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COMBINED LIGHTING AND TRACTION STATIONS.

THE recent opening of a generating station at Cork, designed for a combined lighting and traction load, and the near completion of works having the same object at Plymouth and one or two other places, will afford further opportunities for proving the undoubted merits of the combination. Blackpool, Dover and Halifax already possess works supplying power for lighting and tramways, but in these towns the traction plant has been added to the lighting station, after the latter had been in existence for some time. Other towns, and amongst them Blackburn, Bolton and Derby, are preparing for a similar addition.

The problem of designing a combined station for a town where no electricity works are in operation, is essentially different to that of designing a tramway addition to an existing lighting station. In both cases the desired end is the same, viz., to obtain the combined output with the minimum of plant, and to run that plant with a high load factor for as long a period as possible.

But as the majority of towns possessing, or likely to possess, tramways, already have lighting stations—in many cases with plant unsuited for direct application to tramway purposes—the question of the best way to combine a tramway plant with existing lighting plant is far more difficult to solve, than where the lighting plant can be modified or designed to suit the tramway plant. And this is because, while practically all modern electric tramways require a continuous current, and at a pressure of about 500 volts, existing lighting stations generate, some an alternating and some a continuous current, at pressures varying from 3,000 down to about 110 volts.

In the cases already mentioned of Blackpool, Dover, and Halifax, the lighting is carried out by means of alternating current plant, the added tramway plant consisting of separate engines and continuous current dynamos, steam being taken from existing and added boilers. This arrangement in itself, while giving to the station the benefit of the combined load curve, does not improve the load factor of the lighting plant, since a separate steam-driven lighting set has to be constantly running. In the two latter towns, however, this difficulty has been met by the use of a motor-alternator, which is supplied with current from the traction bus bars during the times of small lighting load, so that no steam plant other than that for the tramways is kept running at those times. A set of accumulators in parallel with the tramway plant serves the triple purpose of keeping an even pressure for the motor-alternator and the tramway feeders, of enabling all steam plant to be shut down at times when the cars are not running, and of helping the tramway generators at times of heavy load.

At Plymouth a modification of the above has been adopted, with a view to lessen the actual amount of machinery, and to increase its usefulness as a combined

plant. Owing to local conditions, the alternating current system is to be used for lighting purposes, but instead of separate engines and dynamos for traction, with a motor alternator for times of light load, the following arrangement has been designed:—An alternator and dynamo are mounted on the same bed, and connected through a clutch coupling to a steam engine. The alternator and dynamo are each for the same output, but the engine is only large enough to drive either at full load. By uncoupling the engine the plant becomes a motor-alternator when desired. Accumulators will be used in parallel with the traction bus bars, and the following combinations are then possible with each set, viz.:—(*a*) Steam alternator for lighting; (*b*) steam dynamo for traction; (*c*) combinations of (*a*) and (*b*) up to the capacity of the engine; (*d*) motor alternator for lighting, driven from the traction bus bars; (*e*) alternating motor generator for traction, driven from the lighting bus bars. Heavy fly-wheels and the accumulators will be relied upon to secure steady running.

The number of continuous current stations generating at between 400 and 550 volts has largely increased during the last few years, owing to the advent of the higher voltage lamp, and the necessity for increasing the pressure on account of the greater distances to be reached by the mains. All recent plants have been put in for 400 volts or over, while a large number of older plants have been remodelled. Even here we find large variations. Some stations have adopted 400 volts as the standard pressure across the outers of their mains, others 420, 440, 460, and a few as high as 500 volts, which is at present the maximum allowed by the Board of Trade.

Owing to the fall of pressure along the feeders, all the dynamos would be made to give a higher voltage than required on the network, and in almost every case they could be made to give 500 volts, either with a little speeding up, or by adjusting the field coils. The machines could thus be used directly for tramway work; but they could not, at the same time, be used for lighting, owing to the negative side being earthed by the tram rails. It is evident, therefore, that the tramways must not be supplied direct from a dynamo which is at the same time feeding a lighting network, or *vice versâ*. All the dynamos may be of the same type, be used for either service at will, and even be driven by the same engine at the same time; but they must be entirely disconnected from one set of mains before being used on the other.

With separate engines, the fluctuations of the tramway load will not affect the lighting; but even during the day-time one set at least must be kept running for lighting purposes. This may be avoided by the use of accumulators, or a motor generator, or by coupling two dynamos and an engine in line, similar to the Plymouth sets.

It is usual in lighting stations for the dynamos to be shunt wound, while in traction stations compound wound machines are the rule. This has given rise to the arrangement adopted at Cork, and proposed for use at Bolton and other places. The dynamos are compound wound; but when used for lighting the series coils are cut out, and the machines give the lower voltage required. When connected for traction, the series coils are brought into operation, and a higher voltage can thus be obtained. For modern continuous current stations this is no doubt an excellent method.

Accumulators will play an important part in the combined lighting and traction station. Properly arranged they make excellent equalisers, so that a constant load may be maintained on the traction plant throughout the day. By charging them when the cars have ceased running, and discharging them at the time of the lighting peak, they will tend to produce that straight load line which all central station engineers desire.

The working of the combined stations which are now running, and which are to start during the present year, will be watched with great interest.

A Problem for the Electrical Industry.

It is customary at this period of the year to offer some remarks upon the chief industrial features of the 12 months that have passed away, and to make some observations upon what presumably lies before us. To review the principal electrical events that have transpired during 1898 is almost an act of supererogation, and to suggest what is likely to happen is to venture into the realms of prophecy, an undertaking usually attended with some hazard. Rather than indulge in more or less obvious retrospection, or to speculate upon prospects, it might be more profitable to deal with the electrical industry in its present condition. That would be by no means an easy task, for electrical affairs as they exist at the present moment are more or less tinged with the events of the past year, and to draw any conclusions one must, more or less, bear in mind what is likely to happen in the future. If the congested state of engineering works and its natural corollary—the difficulty of obtaining electrical plant—be taken as a sign of activity, then we presume electrical engineering was never in a more prosperous condition. But we confess that this wave of prosperity causes us some uneasiness; we are half afraid lest any be submerged. Electricity has not long emerged from its advertisement period, and having demonstrated its utility, there has followed in natural sequence an enormous rush on the central stations. Customers have been somewhat recklessly connected up, the question of lamp factor has been presumably ignored, and when there has followed upon this the failure of manufacturers to deliver machinery, the quandary in which electricity works are placed may be readily appreciated. The dissatisfaction of present consumers, and the inability to meet prospective demands, form together one of the most serious questions before the electrical industry, so far as lighting is concerned.

American Competition.

American enterprise and energy are being well rewarded. America's success in relation to the world's iron and steel business seems to be as great as her electrical prosperity. Our manufacturers must not rest upon their ores because of the existence of a more pronounced friendliness for the States. The rivalry in securing the world's orders will not cease. It will necessarily be more acute, though it will be more friendly. Business is business, and competition is competition, whether the rival be an Anglo-Saxon or a Frenchman. Does the Englishman need any new evidence of the great headway that America is making? It is found in the report that Russia has just placed a big order for steel rails, and the West Australian Government has given a two-million dollar contract for 64,000 tons of steel water-pipe for the Coolgardie mining district—the largest foreign order for finished steel ever sent to the United States. The American iron and steel industry is enjoying an exceptional boom. The same has to be said of our own manufacturers. The amount of business is increasing year by year, but we think that American competition is increasing in larger ratio. *Verb. sat. sap.* The report that American motor-car manufacturers have just received orders for 15,000 motor-cars from Paris may or may not be altogether correct. But the mere rumour serves to remind us that the English motor-car industry is not yet to be classed among our more brilliant successes.

RECENT LEGISLATION IN RELATION TO THE SUPPLY OF ELECTRICITY FOR LIGHT AND POWER.

By FRANK PALFOUR BROWNE, of the Middle Temple, Barrister-at-Law.

In these days, when the careful administration of the law by the Courts of Justice seems, in the eye of the public, to be less important than the constant making of new laws and modification of the old ones by the Imperial Parliament, it is interesting to note, in one relation, at any rate, the effect of law making in relation to industrial development, and to ascertain, if possible, whether this interference on the part of Parliament in what is called the interest of the public is really in that interest or not.

A mere sketch of the history of electric lighting in this country will serve to throw light upon the matter in question. Before 1882 it had been observed that when municipalities desired to obtain the statutory undertakings in their districts which had been authorised to supply gas or water, they had, in most cases, to pay a very large price for undertakings in question. In the case of gas and water undertakings, companies had got powers to supply water or gas in a certain district, and when these companies had derived their powers from Parliament, and were still doing their duty by the public, the local authority was not allowed to compete with them, so that the company enjoyed a practical monopoly.* When, consequently, a corporation sought to purchase, either by compulsion or agreement, the statutory gas or water undertaking within its area, it had to pay a monopoly price for the concern, the net maintainable income being capitalised by a multiplier (the number of years' purchase), which was in proportion to the security afforded by the company's position under the Act.

Now when the scientific problem of electric lighting had been solved, and it became necessary to legislate in connection with the public supply of electrical energy, some people thought it would be in the interests of the public to give companies a concession only for a limited number of years, and at the end of that time to enable local authorities to purchase the undertakings, not as going concerns, and therefore on the basis of the value of the plant at the time when the concessions expired.

The famous old cooking book receipt for cooking a hare began with the prudent advice, "First catch your hare," and the Legislature which thought of expropriating electric lighting capital had forgotten first to catch the capitalist who would invest his capital. The Electric Lighting Act of 1882 limited the period of the concession to be given to companies to 21 years. At the end of that time the local authority was to have the right to purchase the plant of the company, not at the "goodwill value," to put it shortly, but at the value of the plant and apparatus as existing at the date of purchase.

It is to be concluded that the legislators who passed that Act saw that the result would be to make electricity very expensive during the period of the concession, but if they thought that the making of it expensive was the way to encourage investment of capital in the enterprise, or was really in the interests of the public, they were grievously mistaken. If a capitalist is asked to invest his money in an undertaking which is to exist only for 21 years, before he does so he must see his way not only to interest on his money but also to a return of his capital in the time limited. If £100,000 is invested, the capitalists who find it must see their way to get an interest as high or higher than that obtained in the investments from which they have withdrawn their money; but, further, if the capital is not to be returned at the end of 21 years they must see their way to a sinking fund which will replace it at the end of their concession, and that interest and sinking fund must be found by those who consume and pay for the commodity in question, which in this particular instance was electricity. Now the Legislature in the dark having fixed a period of 21 years, which was probably adopted mainly on the analogy of the Tramway Acts, found that they had not encouraged but discouraged electric lighting. All new enterprises involve risk, and having regard to the risks in this connection, capitalists did not see their way to the return of their money, and, consequently, nothing was done under the Act.

Local authorities were too timid to adventure in the matter, and private enterprise would have nothing to do with it. The remarkable fact is that Parliament put an end to electrical development in this country for a period of six years. But the Legislature had to admit its error in 1888, when it passed an Act extending the period of the concession, or in other words, postponing the time of purchase by the local authorities for a period of 42 years (Section 2).

It is well known that since the Act of 1888 became law, there has been a wonderful development in relation to electric lighting in this country. It is no longer a tentative industry, but is established on a sure basis of commercial success. But until recently the undertakers of these enterprises laboured under certain disadvantages, as compared with those who sought investments in other directions.

Electric light companies were only allowed to purchase land for their generating stations by agreement. They might, if they could agree with the owners of property, establish their works in any part of their district; but then, like any other person purchasing land, they were liable to an action if they created a nuisance. In a considerable number of cases the noise and vibration, said to be caused at the generating stations, was complained of, and in some of these cases action was taken against the companies, and injunctions granted to restrain them. This was notably the case in connection with one of the generating stations of the Chelsea Electricity Supply Company, Limited.

This unsatisfactory position of electric lighting companies led, during the last session of Parliament, to the promotion of several Bills, the object of which was to obtain, for the companies promoting them, compulsory powers for the purchase of land, and at the same time to secure for the companies exemption from the ordinary law of nuisance. Two of the largest London companies, the Metropolitan Electric Supply Company, and the Chelsea Electric Supply Company, promoted Bills with that object. Before the Bills came before Parliament, an important Joint Select Committee of the two Houses was appointed to inquire—

"1. Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act of 1882, powers should be given in any cases for acquiring land compulsorily for generating stations, and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners or otherwise.

"2. Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply.

"3. Whether in case of a generating station, however acquired, not being situate within the area of supply, power should be given for breaking up of streets between the generating station and the boundary of the area of supply.

"4. Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities involving plant of exceptional dimensions and high voltage, and if such powers may properly be given, whether any and what conditions should be imposed (*a*) with respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act of 1888. (*b*) With respect to the relations of the promoters to other undertakers, and to local authorities within parts of the area.

"5. Under what conditions (if any) ought powers to be conferred upon promoters seeking power to supply electrical energy to other undertakers and not directly to consumers."

Now, although the Bills then pending in Parliament were not referred to the Committee, the reference to the Committee bore directly upon these private Bills. No. 1 of the instructions had a direct reference to the proposal of the Chelsea Electric Supply Company, which proposed to acquire land compulsorily within its area of supply. Nos. 2 and 3 had direct reference to the proposals of the Metropolitan Supply Company, which proposed to acquire land for a generating station at Willesden, outside its area of supply, and to break up the streets between the generating station and the boundary of their district. No. 4 had direct reference to the Bill for the incorporation of the General Power Dis-

* See Public Health Act, 1875, Sections 52 and 161.

tributing Company, to which we will refer hereafter, and No. 5 referred to the proposal of the Central Electric Supply Company, Limited, who by their Bill sought to acquire compulsorily a site on the Regent's Canal, and proposed to supply electricity to companies and corporations—more especially the St. James's and Pall Mall Electric Supply Company and the Westminster Electric Supply Company—but did not propose to supply direct to consumers.

After inquiry, the Committee made a report which may be described as another step in the right direction. It is not necessary here to quote the report where it answers the latter questions, but the answer to the first is so important that we venture to transcribe the greater part of it:—

"(*a*) The proved public advantage of electrical energy in the generation of light and power warrant, in their opinion, the granting to undertakers of compulsory powers for acquiring sites for generating stations and lands or easements for pipes and mains therefrom, and other works."

In (*b*) they say that these powers should be given by provisional orders confirmed by Parliament, and that procedure by private Bill should be reserved, as at present, for exceptional cases.

In (*d*) the report says:—"With respect to the liability for nuisance, they are of opinion that when the site for a generating station is acquired under compulsory powers, and is specified so in the provisional order or special Act, the undertakers should not be subject to any further liability than that which, according to Lord Blackburn (Geddes *v.* Bann Reservoir, 3 App. Cas. 455),* is imposed by the common law in the case of persons exercising statutory powers and duties. On the other hand, when the site for a generating station is acquired by agreement, they think that the undertakers ought to be subject to the liability imposed by the common law."

We said that this was another and important step in the right direction. It was in effect freeing the enterprise from some of the legislative trammels which had been wormed round it, and putting it in the same position as other enterprises which subserve public wants and conduce to public convenience and comfort. We cannot but think that the effect of this legislation will bear fruit in the immediate future, and the electrical enterprise will now fall on good ground and bear good fruit, whereas in the past it has fallen by the wayside and if it sprung up at all it was choked by the thorns of legislation.

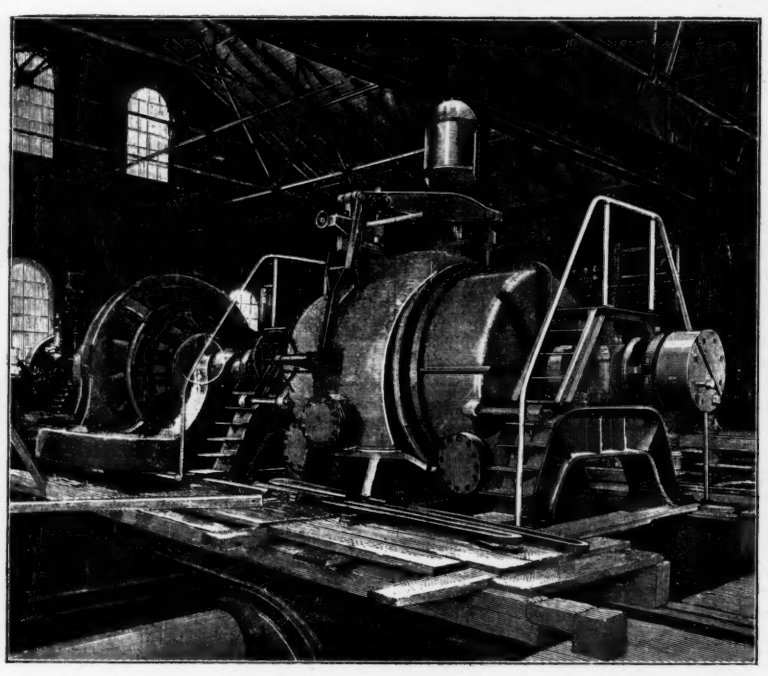
(*To be continued.*)

* Lord Blackburn's opinion is in these words:—"It is now thoroughly well established that no action will lie for doing what the Legislature has authorised if it is done without negligence, although it does occasion damage to anyone; but an action does lie for doing that which the Legislature has authorised if it be done negligently. And I think if, by a reasonable exercise of the powers either given by statute to the promoters or which they have at common law, the damage could be prevented, it is, within this rule, negligence not to make such reasonable use of their powers."

THE NEW 2,500 HORSE-POWER TURBINES AT NIAGARA.*

In our issues of March 6th, 1897, and June 18th of last year, we gave illustrated descriptions of the celebrated power house at Niagara. In the present issue we show a pair of Greyelin Jonval horizontal axis turbines, which have lately been installed at the works of the Niagara Power and Manufacturing Company by R. D. Wood & Co., of Philadelphia.

This pair of turbines forms part of a series of turbines composed of five pairs, each pair to be 2,500 horse-power. They will be attached to a 13-foot diameter inlet tube, which tube directs the water from the top of the upper level of the fall to within 20 feet of the bottom of the fall, at which elevation a horizontal tube runs over the whole length of the wheel pit, into which the spent waters are to be discharged. On the upper part of this horizontal tube are provided five openings, on which slide gates of 60 inches diameter are attached. Each of these gates is acted upon by a hydraulic plunger, operated by the pressure of the water.



The pair of turbines lately started is placed 24 feet above the lower level of the fall. The water, after acting on the blades of the turbine, is directed to two draught tubes, the extremities of which plunge into the tailrace water. This application of draught tubes in this case is specially desirable, as it enables the dynamos, which are directly attached to the extension of the turbine shaft, to be removed far above the tailrace water, thus escaping dampness.

The water is admitted to the central chamber, in which is placed a register gate, controlled either by hand motion or by a governor for regular work. The water from the gates, which are placed opposite to each other, is admitted to the guide blades, which direct the water to the blades of the two revolving bronze wheels. These blades, with a view to high efficiency, are carefully designed and highly polished, so as to reduce friction. The water leaving the two revolving wheels discharges into two draught tubes, the lower extremity of which plunges into the tailrace water. The whole structure rests on a framing of steel beams, secured by the side walls forming the tailrace. To prevent leakage of water, hydraulic grooves are provided, both in the movable part and the stationary part.

The turbines are 70 inches mean diameter, of 36 blades, and each one has 142 square inches. They are secured on a horizontal axis of 11½ inches diameter in the middle, tapering down to 8 inches. The turbines make 250 revolutions per minute, and they are supported on self-oiling bearings of 30 inches length by 8 inches diameter, supported on stout stands resting on the steel frame above mentioned. Each end of the shaft is provided with thrust bearings, so as to neutralise any end pressure that may be caused by a tempo-

* *Scientific American.*

rary obstruction in one or the other of the turbines. The prolongations of both shafts are provided with couplings, to which dynamos are directly connected. To-day, however, but one dynamo is in position, absorbing about 1,100 horse-power.

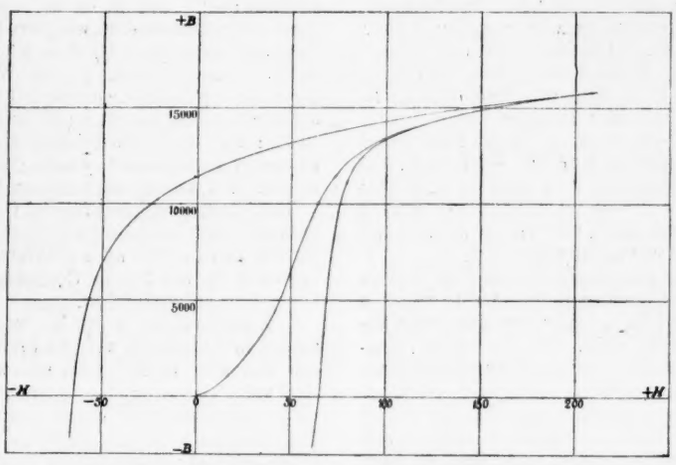
The placing of turbines in pairs on horizontal axes has, within the last 10 or 15 years, become a favourite mode of using water-power, as, by placing the turbine shaft above the tailrace water, every part is made accessible. This mode of absorbing the power of hydraulic motors has become specially desirable, since the generators may be in many cases direct connected with the turbine shaft, thus saving any loss by the use of belting. Mr. E. Greyelin informs us that when, 44 years ago, he placed two pairs of turbines on a horizontal axis, he little realised the advantages in the way of neutralising the end pressure that would be secured by this method.

MAGNET STEEL.

The diagram below is a copy of one issued by the Reichsanstalt with a report on two samples of magnet steel exhibited by Messrs. J. J. Saville & Co., of Sheffield. It is of interest from several points of view. The material compares fairly with the best known tungsten steel, the Allevard steel. Calling the coercivity H_c, and the residual intensity of a closed magnetic circuit, after magnetisation in a strong field, I_r, we have the following :—

	B_c.	I_r.
Allevard steel ...	... 73 ...	... 850
Saville's steel ...	... 69 ...	... 917

While the Allevard has a higher coercivity, it is possible that Saville's steel may make the more powerful, if less stable magnets. The comparison between the values of I_r is somewhat uncertain, as the observations were not taken with precisely the same conditions, but there should be no doubt about the comparison of the coercivities. Saville's steel is, we believe, recognised as the best English magnet steel, and has been used by the Post Office for their instruments.



Magnetic curve of a sample bar of J. J. Saville & Co.'s steel.
Traced from diagram of Reichsanstalt test No. 26.
$H_c = 65$. $B_r = 11{,}730$. $I_r = 917$.

Another point of interest lies in the fact that this report comes from the Reichsanstalt, and was obtained for the purpose of a foreign trade. Evidence given before the recent commission on the foundation of a national laboratory abundantly proved the beneficial effect on manufacture of scientific and exact comparisons instituted between materials and instruments submitted, and nothing could tend more directly to the improvement of magnet steel than the issue of such reports as the one before us. The problem to be solved by the steel maker is stated in a definite and easily comprehensible form, viz, to obtain the highest possible coercivity and a high resultant intensity; and his degree of success in solving it is measured by a definite figure which cannot be controverted, whose value as a certificate of merit is incomparably greater than any number of trade testimonials of vaguely satisfactory results obtained. These latter are generally the only available information on the quality of any steel. The magnetic qualities of steels must almost certainly receive the early attention of the new laboratory when the pain of its prolonged parturition is past.

A MODERN ELECTRIC CENTRAL STATION.

In a paper presented to the American Institute of Electrical Engineers, Mr. G. A. Damon describes the plant of the Imperial Electric Light, Heat and Power Company, of St. Louis, Missouri, as being a good example of the present tendency in electric generating station practice. The district to be served is a town district with a good demand for arc and incandescent lighting for stores, hotels, offices, and theatres, and for more than the ordinary amount of motor service for elevators and light manufacturing, and the engineers had a free hand to adopt whatever plans they considered best to insure reliability and economy of working. The system adopted was a three-wire direct current distribution, with 440 volts between the outers, the current being supplied to the network through three-wire feeders from generators at a pressure of 440 to 500 volts, working in conjunction with a storage battery.

The cost of real estate being considerable, the station was arranged as compactly as possible by placing the engine house and boiler house on the ground level, the battery room in the basement below the engine house, the coal stores, ash handling apparatus, piping, pumps, hot well and condenser in the basement below the boiler house, and the offices, stores, and repair shop on the first floor. The boilers are of the horizontal water-tube type, working at 175 lbs. pressure, and are fitted with down-draught furnaces and water-cooled grates; and at the back of and above each pair of boilers is placed an economiser carried on a special iron framing. The flue leads to a steel chimney of the minimum height allowed by the local regulations, the draught being produced and controlled by a fan. The engines are compound condensing vertical engines of the marine type, each piston acting on a separate crank, and are provided with a heavy fly-wheel fixed on the shaft between the two cranks. The high pressure cylinders are steam jacketed on the barrel and ends, and the low pressure on the ends, and the receiver is fitted with copper reheating coils. The steam from the engines exhausts into a surface condenser, from which it is pumped into the hot well, and thence through the economisers back into the boilers. The condensing water is taken from the bottom of a cooling tower about 30 feet high, which is built on the roof at a height of 50 feet above the condenser; and from the condenser it is returned by centrifugal circulating pumps to the top of the cooling tower. It is interesting to note that the main engines are the only steam-using plant in the station, all pumps and other auxiliary apparatus being electrically driven.

The dynamos are of the multipolar type with ironclad bar-wound armatures, and are constructed so that the magnet frames can be shifted parallel with the shaft a sufficient distance to allow the magnet coils to be removed and the armatures got at for repairs. Each dynamo has a normal output of 500 kilowatts at 150 revolutions per minute, and the battery of accumulators, which has a capacity of 2,000 ampere-hours at its normal rate of discharge, is capable of standing a discharge at the rate of 500 kilowatts for one hour, or equal to the output of one generating unit. Two 50-kw. boosters, driven from the main engines, are provided for charging the battery, each being capable of adding any voltage that may be required up to 130 volts.

Probably the most novel feature of this station is the

arrangement of the generating plant, which is installed on what is known as the Arnold system, the idea of which is to improve on the usual arrangement of direct coupled units by mounting each generator so that it can be operated by more than one engine. Although at present only three dynamos are erected, the first line of plant in the St. Louis station will eventually consist of three engines, one of 1,500 H.P. in the centre, and one of 750 H.P. at each end, and of four dynamos and two boosters, two dynamos and a booster being mounted between each 750-H.P. engine and the 1,500-H.P. one. Under normal conditions each dynamo will be operated by the engine nearest to it; but in case of accident to any machine, it is possible, by means of the special system of coupling, to operate any one or all of the dynamos by the 1,500-H.P. engine, or to make each of the 750-H.P. engines drive either or both of the dynamos between it and the central engine. This object is attained by mounting each dynamo armature on a hollow shaft, carried in independent bearings, and the booster armature on a solid shaft, which extends from engine to engine through the hollow shafts without touching them, and which also is carried in independent bearings. The coupling, which is a magnetic clutch, consists of three discs, one connected to the engine shaft, and one to the hollow shaft of the adjacent dynamo, whilst the third, which is somewhat smaller in diameter than the other two and lies between them, is connected to the solid shaft. Each of the outer discs is provided with annular coils of wire, sunk in grooves in the disc face, and by passing a current through one or more of these coils, the following combinations can be made, viz, the engine shaft can be coupled to either the hollow or the solid shaft, or to both at the same time, or the hollow and solid shafts can be coupled together, whilst the engine shaft remains disconnected from both of them. If we consider a group of two engines, A and B, with the two dynamos, A_1 and B_1, which are mounted between them, the normal conditions are that dynamo A_1 is driven by engine A, and dynamo B_1 by engine B; but if the latter breaks down, dynamo B_1 can be driven from engine A by coupling both A and B_1 to the solid shaft. If, at the same time, the dynamo A_1 were to break down, it can be disconnected from the engine, A, without preventing this latter from operating dynamo B_1. The booster, which would not exist in other lines of plant added for extensions, can of course be driven from either engine by coupling the engine disc to the solid shaft, and the only inconvenience which may be caused by it, is that when driving a dynamo by the engine which is not next to it, that is, through the solid shaft, the booster must be run round whether it is wanted or not for the service.

The arrangement is an ingenious one, and as both engines and dynamos are constructed so as to be able to stand a heavy overload, it is claimed for it that it does away with the necessity of providing reserve units. We do not see, however, in what manner the Arnold system is superior to the plan of using independent generating units, each of which is capable of standing a good overload, except in the case of the simultaneous breakdown of the engine of one unit and the dynamo of another; and even then, as we shall see later, the advantage is not always with the Arnold system. The weak point of the Arnold system is the central engine of twice the power of each of the end ones, as if this breaks down it not only causes a 100 per cent. overload of the other engines, but it also divides the line of plant into two independent sets; so that, if one dynamo also breaks down, the conditions are either that one engine and the one dynamo it can drive must both work at 100 per cent. overload, or if the other two dynamos are allowed to take a share of the overload, the engine which drives them must work at more than 100 per cent. overload. On the other hand, with four equal and independent units, if one breaks down each of the others must take a 33 per cent. overload, or if two sets are unfit for service at the same time each of the remaining two would have to work at 100 per cent. overload; that is to say, they would be in no worse case as regards overload than if they were arranged on the Arnold system, and all the expense and complication of hollow shafts and magnetic clutches are avoided. But with independent units there is no need to restrict the number to four, and if we suppose the plant to consist of six units instead of four, we find that the advantage is all on the side of the independent plants, as if each unit is capable of standing an overload of 50 per cent., the independent units can do all that the Arnold plant could do if each engine and dynamo in this latter case were constructed to carry an overload of 100 per cent.

INTERNATIONAL COMPETITIVE TRIALS OF ACCUMULATORS FOR ROAD TRACTION.

The competitions between automotric hackney carriages organised by the French Automobile Club supplied valuable data relative to the electric power and energy consumed by the various vehicles under given conditions. But, since the accumulators used were all of the Fulmen type, and the time over which the trials extended was altogether insufficient for any test of durability, the competition was necessarily barren of results bearing upon the comparative value of different forms of accumulator which have been put forward as being eminently suitable for traction. It can only be said that the Fulmen accumulator gave excellent results during the nine days over which the competition extended, leaving open the important questions as to its durability and as to the possibility of a practical superiority on the part of batteries giving a far lower rate of discharge and having a much smaller specific capacity.

Several members of the Committee for the Cab Competition were of opinion that an Accumulator Competition had become an absolute necessity. On the proposition of M. Jeantaud, the club voted that this suggestion should be acted upon; and a special committee of 31 members was appointed to organise a competitive trial of accumulators.

An authoritative and unbiassed test of this nature has, in our opinion, been too long delayed; it should, we think, have been carried out long ago in this country. It is within three months of three years since the following appeared in our columns:—"A period, let us hope, is approaching, when practically accurate data will have to be taken into consideration and acted upon by those who come before the public with electro-automotric systems. With accumulators intended for other applications, commercial success may sometimes be achieved by bold assertion and an extensive system of advertising; but, in electric traction, short shrift will be given to secondary batteries and systems that are found to be deficient as compared with others that may be available."

The above-mentioned Special Committee has, in its turn, nominated a sub-committee to arrange the details of the experiments and to draw up a programme. This programme, as approved by the Special Committee and by the Automobile Club, is reproduced below.

The competition is to be confined to accumulators intended for automotric vehicles driven on ordinary roads. It has also been decided that, with a view to testing the practical value of the appliances from the point of view of the special application for which they are intended, the accumulators shall be, during discharge, subjected to mechanical vibrations and jolting similar to those to which they might be exposed on roads maintained in an average condition of efficiency. The rate of discharge is to be varied within wide limits during certain periods, alternating with intervals of rest, according to the diagram given below. The mechanical vibration and the variations in the rate of discharge are to be the same for all the batteries submitted to the tests, and the required capacities and rates of discharge are to be those which the cab competition has shown to be necessary for street traction.

With a view to ascertain the condition of each battery, constant current discharges are to be taken from time to time, which will determine a methodical and successive elimination of batteries which, by reason of waste of active material or deterioration, no longer exhibit a sufficient capacity.

In order that the competition may not be confined to accumulators in which the active materials are spongy lead and lead peroxide, the Committee has not fixed the number of plates to be used, but only the potential difference below which no battery is to fall at the end of each constant current discharge. The batteries will thus be compared under strictly the same conditions from the point of view of the discharges. It is for the manufacturers to so proportion the

weight of the elements that the conditions of the programme may be complied with as perfectly and for as long a period as possible.

In regard to the charging of the cells, the Committee has considered that each competitor should be allowed to a certain extent to regulate the rate, provided he remain within the conditions of practice. This would seem to imply that no particular density of current will be imposed; but the meaning is rendered somewhat obscure by the wording of the following rule, viz.:—

"It has thus been decided that the accumulators shall be equally charged in series with a current decreasing, nearly regularly, in eight hours, from 30 to 15 amperes. For each charge the competitor is to indicate the initial current at which his battery may be circuited and the quantity of electricity to be supplied to it."

The expression "equally" is puzzling; but it would seem that all the accumulators are to be connected in series, but that any one of them may be short circuited until the decreasing current has fallen to any required extent. This arrangement, says the Committee, as reported by *L'Industrie Electrique*, has the advantage of necessitating no alteration in the connections of the batteries for charging or discharging, and it facilitates the measurements.

To avoid any exaggerated estimate on the part of the competitors of the surcharges given to their respective batteries, each of these will be connected to an energy meter, which will measure the quantities (watt-hours) given and expended each day; it will determine the daily efficiency, the mean efficiency, and the total quantity of energy supplied by the battery prior to its becoming unserviceable.

All the results of the competition will be given in a detailed report. If they do not reveal the existence of the ideal accumulator they will at least exhibit the present stage of progress, and, the Committee ventures to hope, will indicate the path to be followed to arrive at future improvements.

Programme of the Competition.

Article 1.—Under the patronage and direction of the Automobile Club of France, a society of encouragement for the development of the automobile industry, an international competition is organised between manufacturers or inventors of accumulators for automobile carriages circulating on ordinary roads.

Article 2.—The competition will take place at Paris on the second Monday in April, 1899, and on following days.

Article 3.—The competition will bear upon the following points:—

(*a*) The durability of the elements.

(*b*) The commercial efficiency of the battery, *i.e.*, the ratio between the energy supplied at the accumulator terminals during charge and the energy yielded during discharge.

(*c*) The frequency, importance, and facility of the operations necessary for maintenance.

(*d*) The weight of the accumulators as compared with their rate of discharge and their capacity.

These points are to be determined under conditions of jolting and variation of rate of discharge as nearly as possible similar to those which accumulators would undergo when in action on automobile carriages.

Article 4.—The number of batteries is not limited; but no competitor can submit several batteries of the same type.

Article 5.—For every battery submitted, an entrance fee shall be paid, viz., 500 francs if paid prior to January 31st inclusive, or double that amount if the payment be made between that date and February 28th, 1899, when the list of competitors will be finally closed at midnight.

Each application for inscription must be accompanied by the entrance dues, which will not in any case be returnable. The Committee mentioned under Article 14 may, however, grant a reduction of one-half of the dues in the case of competitors who, in their opinion, may merit such reduction.

Article 6.—The batteries, in a charged condition, must be delivered at the premises reserved for the competition on Tuesday, April 4th, in order to allow for the time which is necessary for the installation of measuring and recording instruments, and of the apparatus for discharge and for vibration or jolting. On the same day the competitors must remit to the president of the Committee a descriptive notice, accompanied by all necessary drawings and specimens. This notice must also state the selling price of the battery.

Article 7.—The competition tests will, as a rule, be continued as long as may be necessary to render all the batteries unserviceable. The tests will, however, be discontinued after the expiration of six months.

Article 8.—Each battery submitted to the competition, composed of a suitable number of elements enclosed in a containing tray, must not weigh more than 110 kg. (242 lbs.) exclusive of the containing tray. The battery must be able to yield 120 ampere-hours at the constant rate of 24 amperes during five hours, without a fall of potential difference below 8·5 volts.

Article 9.—The tests will take place in periods of six days separated by a day of rest.

One day each week the batteries will be discharged in series, without jolting, at the constant rate of 24 amperes during five hours. Every battery in which the potential difference at the terminals falls during these tests below 8·5 volts will be cut out of circuit. After being four times cut out of circuit, the battery will be definitely withdrawn from competition.

The seventh day (Sunday) will be one of the days of rest.

Article 10.—The charge is to be effected within the maximum period of eight hours, on the batteries connected in series, with a decreasing current of which the initial strength shall not be above 30 amperes, and the final strength shall be about 15 amperes. The charging of each battery shall be stopped each day on the order of the competitor or his duly accredited representative.

Article 11.—During the intervals of rest between discharge and charge, which intervals are never to exceed two hours, the competitors, or their representatives, shall be authorised to inspect their batteries, to maintain the strength of the electrolytic solution, and to clean the elements; but they will not be allowed to change any plate or add anything to it.

Article 12.—Besides an ammeter measuring the total quantity of electricity supplied to and from the batteries as a whole, an energy meter (wattmeter) attached to each battery will measure the quantities of energy absorbed by and supplied to (?) each of them, so as to allow of the determination of their commercial efficiency.

A commercial voltmeter attached to both poles of each battery will allow of the variations of potential difference during successive charges and discharges being noted. This instrument shall, from time to time, be calibrated by means of a standard voltmeter.

During five other days the batteries will be subjected for five hours, by means of an automatic apparatus, to vibration and jolting as nearly as possible analogous to what they would experience on automobile carriages travelling on ordinary macadamised or paved roads.

During these five hours the batteries, connected in series, will be worked at variable rates of discharge according to the table and diagram below.

This diagram of discharge, realised by means of a commutator making one revolution to the half-hour, will be repeated 10 times in succession, each complete revolution corresponding to a quantity of electricity practically equal to 12 ampere-hours.

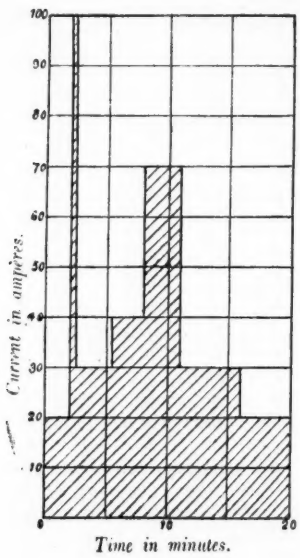
Table of Accumulator Discharge.

Current in amperes.	Duration in minutes.	Quantities of electricity in ampere-minutes.
20	2	40
100	0·5	50
30	3	90
40	2·5	100
70	3	210
30	5	150
20	4	80
0	10	0

Article 13.—The current will be supplied by the Committee to the competitors at the expense of the latter, at the maximum price of 1 franc per kilowatt-hour; all other costs being defrayed by the Automobile Club.

is capable of standing an overload of 50 per cent., the inde- discharges. It is for the

Article 14.—The carrying out of this programme will be entrusted to a Committee composed of members of the Automobile Club who are *bonâ fide* non-competitors. In addition to



the members of this Committee, its President may utilise the services of electrical engineers appointed by him to carry out the trials and to exercise the necessary supervision.

As a condition of their inscription, the competitors undertake to abide by the decisions of this Committee, which is to be the sole judge in all questions that may arise out of the application of the present programme.

Article 15.—This Committee will be charged with the drawing up of a detailed report. In addition to the latter, it will from time to time publish an abstract of the results obtained.

Article 16.—Medals and diplomas may be awarded to the competitors.

Article 17.—All civil and penal responsibilities must be met by the competitors on whom they may devolve; it being understood that the Automobile Club declines all responsibility of any kind.

THE SULZER STEAM ENGINE.

II.

Experimental Results.

We now propose to treat the important question of economy in this type of engine. As we have already said, the Sulzer engines are usually horizontal condensing, are always provided with very effective steam jackets, and four valves to each cylinder, and are made double-acting.

In *Engineering*, for January, 1892, a series of 23 experiments were published on single cylinder, compound, and triple Sulzer condensing engines, and before proceeding to consider more modern tests, it may be well to give the chief results of these trials. The best and most accurate way of stating and comparing results thus obtained is that recommended by the Steam Engine Efficiency Committee of the Institution of Civil Engineers, namely, to give the heat or number of thermal units required per minute, per indicated and per brake H.P. Unfortunately these figures are not reported in these earlier experiments. We must, therefore, be pardoned if we revert to the old fashioned way, and give the consumption in pounds of steam or feed water per I.H.P. per hour, disregarding the fact that the pressure of steam varied in the different experiments.

The first series consists of five experiments on *single cylinder* engines, with steam pressures of from 72 to 95 lbs. per square inch, and piston speeds varying from 272 to 433 feet per minute. The I.H.P. was from 157 to 400, the steam consumption, excluding the water condensed in the steam pipe between the boiler and the engine, but including all steam jacket water, was 17·9 to 19·2 lbs. per I.H.P. per hour, or a mean of, say, 19 lbs.

The next series of ten experiments were on *compound* engines. Here the steam pressure varied from 84 to 104 lbs., and the piston speeds from 385 to 689 feet per minute, the engines indicating from 133 to 524 H.P. The steam consumption, taken as before, rose from a minimum of 13·4 lbs. to a maximum of 15·5 lbs. per I.H.P. per hour, or a mean, say, of 14·3 lbs.

In the *triple* engine series of six experiments the steam pressure was from 104 to 156 lbs. per square inch, and piston speeds from 444 to 607 feet per minute. The I.H.P. varied from 200 to 615, and the steam consumption, taken as before, from 11·7 to 12·7 lbs. per I.H.P. per hour, or a mean of 12·18 lbs. We may therefore say that with these three types of engines, having one, two, and three cylinders, the relative steam consumption, deducting and including the quantities given above, are respectively 19·0, 14·3, and 12·2 lbs. per I.H.P. per hour. With a good boiler and saturated steam, and a good coal giving 10 lbs. evaporation per pound of coal, these figures are equivalent to 2 lbs., 1½ lbs., and 1¼ lbs. of good coal per indicated horse-power per hour.

Since the publication of these trials in 1892 better results have been obtained, as we will now proceed to show, and various improvements effected. The single cylinder engines have one crank, the compound horizontal are sometimes made with the cylinders tandem, working on to one crank, sometimes side by side with two cranks, the fly-wheel being in the middle. In the triple horizontal engines two cranks are usually adopted. Two cylinders are connected to one crank tandem, and one cylinder to the other, with the fly-wheel in the centre. Numerous trials have been made on engines of this modern type. We subjoin particulars of three, carried out on *triple* condensing steam jacketed Sulzer engines, both horizontal and vertical, two working with saturated, and one with slightly superheated steam.

The first experiment at a large mill near Moscow was on a horizontal engine with cylinder diameters of 26 inches, 39·4 inches, and 59·1 inches respectively. Stroke 47·25 inches. Revolutions per minute 76, giving a piston speed of 600 feet per minute. Here the high pressure and intermediate cylinders act on one crank, and the low pressure cylinder on the other, with a fly-wheel for 32 ropes in the centre. The engine works with saturated steam, and an injection condenser is used. In addition to the ordinary governor a second is provided, which regulates the steam stop valve, if the normal speed is exceeded by two revolutions a minute, and also opens an air valve, thus annulling the vacuum and bringing the engine rapidly to a stand. Tests were made in 1893 with a boiler pressure of 150 to 160 lbs. per square inch. The load varied from 1,150 to 1,250 I.H.P., and the weight of steam passing through the cylinders and jackets per I.H.P. per hour was 11·7 lbs.

The next trial was made on a horizontal *triple* condensing engine driving a cotton mill at St. Petersburg. There are four cylinders, high pressure, intermediate, and two low pressure, and they are arranged tandem, with two cylinders coupled to each crank, at an angle of 90°. The cylinder diameters are respectively 30 inches, 44·5 inches, and two of 51·6 inches, with a stroke of 78 inches to all four. Number of revolutions per minute, 56; piston speed, 725 feet per minute. There are two air pumps, and 36 ropes on the fly-wheel. Four careful experiments were carried out on this engine in 1895, the indicators being previously tested. The I.H.P. varied slightly from 1850 to 1897. The steam consumption, excluding the water in the steam pipes, but including all the steam jacket water was from 11·18 lbs. to 11·37 lbs. per I.H.P. per hour, giving a mean of 11·3 lbs. In these interesting experiments the steam was cut off at about 18 per cent. of the stroke in the high pressure cylinder.

The third experiment was on a horizontal *triple* engine in Germany, and is especially noteworthy because it was made with steam slightly superheated, viz., about 17° F. As might be expected the superheat quickly disappeared in the high pressure cylinder, nevertheless, as will be seen, it produced a considerable economy, the important point being to have in any case dry steam in the high pressure cylinder.

The diameters of the three cylinders were 20·5 inches, 31·5 inches, and 47·25 inches respectively, with 55·2 inches stroke; revolutions per minute, 66; piston speed in feet per minute about 600. There were two cranks coupled at 90°, the high pressure and intermediate cylinders worked tandem on one, and the low pressure cylinder on the other. The steam pressure was 170 lbs. per square inch, cut off in the high pressure cylinder about one-fifth. Two tests, of which we give the average results, were made on this engine in 1895, when it indicated from 630 to 735 H.P. The steam consumption was 10·8 lbs. in the first, and 10·7 lbs. in the second trial. In the writer's opinion this is a very remarkable result, probably the best on record for the degree of superheat. It is only fair, however, to add that it is not quite accurate to compare the consumption in pounds of steam per I.H.P. per hour when dealing with saturated and superheated steam, because there is more heat per pound in the latter. Allowance should be made for this, and the results should, if possible, be stated in T.U. per minute per I.H.P. In the trial here considered, as the degree of superheat was so small, the error is probably very slight.

One of the latest and most economical trials on a Sulzer engine was made at St. Gall in 1897, on a *triple* horizontal condensing engine, provided with superheater and economiser. The former, however, was not used, and the steam at 150 lbs. pressure per square inch was only dried. The engine had two cranks, and all the cylinders and covers were jacketed with steam. The diameters of the three cylinders were $14\frac{3}{16}$ inches, $23\frac{5}{8}$ inches, and $34\frac{7}{16}$ inches respectively; stroke, $39\frac{3}{8}$ inches; revolutions per minute, 60. Four trials were made, and the number of T.U. required per I.H.P. per minute were fortunately given in each case. The engine drove a pump to supply water from the Lake of Constance to the town of St. Gall. The I.H.P. varied from 201 to 207. The consumption of steam per I.H.P. per hour was from 11·5 to 12 lbs., and the T.U. per minute per I.H.P. varied from 211 to 220.

In conclusion, we would call the attention of our readers to the remarkably economical results of these engines, particularly, as already noticed, in those using dry or superheated steam. With a good boiler and good coal the consumption here given is equivalent to 1 lb. of coal per I.H.P. per hour. Engineers should study these figures with attention and interest, and compare them with the results obtained in experiments on other types of engines.

SOME METHODS OF MEASURING HIGH POTENTIALS WITH LOW POTENTIAL INSTRUMENTS.*

By SAMUEL J. BARNETT, Ph.D.

In the course of a recent investigation,† necessitating the use of electrical charges at high potentials, it devolved upon the writer to develop some means of measuring such potentials with low potential instruments; the result being that two methods were devised by which the range of an electrometer or ballistic galvanometer may be almost indefinitely extended:—

1. One of the methods consists in applying the whole potential difference to the terminals of two condensers arranged in series, and measuring the fall of potential between the plates of one of them. From this and the *known* ratio of capacities the whole potential difference at once follows. Then let C_1 and C_2 (fig. 1) denote two condensers (and their capacities) arranged in series, and having the joint capacity C; let the electrometer, E, be connected to the coats of C_1, the terminal coat of which is earthed, and let V be the total fall of potential through the series, and V_1 that through C_1. Then we have, including in C_1, the capacity of the electrometer,

$$C V = C_1 V_1 = \frac{C_1 C_2}{C_1 + C_2} V; \text{ whence } V = V_1 \frac{C_1 + C_2}{C_2}.$$

By suitably adjusting the ratio $\frac{C_1 + C_2}{C_2}$, an electrometer (or ballistic galvanometer) of any convenient range may be used to measure any difference of potential within its range or higher, except in so far as leakage, absorption, &c., render the indications of the instrument unreliable. That these

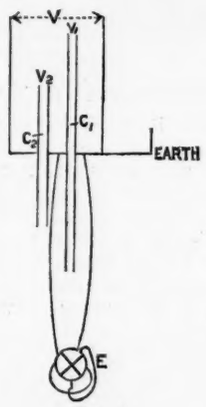


Fig. 1.

indications may be trustworthy, the ratio of capacities, including the absorption and leakage, must remain throughout the observations the same as the ratio of calibration. This ratio, in the investigation above mentioned, was 75 to 1, enabling a Kelvin quadrant electrometer to measure potential difference as great as 30,000 volts. Although this method had not been used previous to this investigation, so far as my knowledge goes, yet the principle on which it is based has been of service to Lord Kelvin since 1885* in the calibration of electrostatic voltmeters, &c.

2. The other method is an inversion of Faraday's well-known method of comparing capacities: The ratio of capacities being known, the *initial* potential difference can be computed from the *final*, which may be made as low as desired by suitably adjusting or selecting the condensers to be used. Thus, let C_1 and C_2 (fig. 2) be two condensers (and

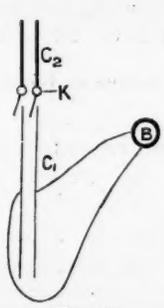


Fig. 2.

their known capacities), which can be connected in multiple through the switch, K; the terminals of an electrometer, or, better, a ballistic galvanometer, B, are connected with the coatings of C_1. The potential difference to be measured, V, is applied to the plates of C_2; C_2 is then insulated and immediately put in multiple with C_1, reducing the potential difference to V_1 by increasing the capacity to $C_1 + C_2$, where instantaneous discharge occurs through the galvanometer, B. Here we have

$$C_2 V = (C_1 + C_2) V_1;$$

whence, as in method (1),

$$V = V_1 \frac{C_1 + C_2}{C_2}.$$

From the known capacity, $C_1 + C_2$, and the galvanometer deflection, V_1 is readily found. This method possesses a

* The first method here given was described as a portion of a paper, "On the Surface Tension of Liquids under the Influence of Electrostatic Induction," *Phys. Rev.*, 6, p. 257, 1898.

† l. c. ante.

* *Proc.* B. A. A. S., Aberdeen, p. 907, 1885.

great advantage over (1), in that it avoids completely the troublesome effects of absorption and leakage, the whole process of arrangement in multiple and final discharge being practically instantaneous.

Colorado College, Colorado Springs.

CORRESPONDENCE.

On the Recovery and Refining of Nickel.

The "Notes on the Recovery and Refining of Nickel," by Mr. Sherard Cowper-Coles, which appeared in the last issue of the ELECTRICAL REVIEW, pp. 926-927, remind us of Queen Anne's death, and do not add anything to our knowledge.

We have heard before of the processes described by Mr. Cowper-Coles, and I must be allowed to say that when an electro-chemical question is treated in a journal of such a high standing as the ELECTRICAL REVIEW we are entitled to hear of some new ideas, or if it is a mere compilation, we may expect that it will present to the reader, in a clear and comprehensible manner, a complete summary of the best methods which have been devised, and which give the most satisfactory results. Besides, such a description should be accompanied with remarks and criticisms made from a technical point of view by the writer, who should have made some prior experiments on the subject. We do not care for articles on electrolysis made at the British Museum Reading-Room or in any other library, from extracts of English and foreign books and periodicals; but we appreciate articles such as those of your late contributor, Alexander Watt, who never wrote in the ELECTRICAL REVIEW a line on electro-chemistry unless he had made experiments and careful investigation.

The "Notes on the Recovery and Refining of Nickel" do not resemble at all the articles written by Alexander Watt, as I am sorry to say that they appear to be merely copied, almost word for word, from books and scientific publications which ought to have been quoted by Mr. Cowper-Coles.

Leaving aside the paragraphs which do not refer to the electro-deposition of nickel, I will, in the first place, point out that the sentence for an "English patent filed in 1840," &c., &c., is taken almost *verbatim* from p. 395 of "Electric Smelting and Refining," the second edition of "Elektro-metallurgie," by Dr. W. Börchers, translated by W. McMillan.

Then follows the passage on Böttger, which is borrowed from Börchers (*vide supra*).

The paragraph commencing "In Andre's process" is taken from the same book, pp. 395-396.

Mr. Cowper-Coles says:—	Mr. W. Börchers says:—
Hoepfner has patented a process for using a purified neutral solution of nickel which he then acidifies with a weak and freely *conductant* oxygen acid (citric or phosphoric acid) which is electrolysed with the aid of insoluble anodes. The anodes are immersed in cells containing a solution of the chlorides of a more electro-positive metal.	Hoepfner prepares a purified neutral solution of nickel; this is then acidified with a weak and freely *conductant* oxygen acid (citric or phosphoric acid), and is electrolysed with the aid of insoluble anodes.

The following paragraph is a literal reproduction of page 430 of *Mineral Industry* for 1896, in which Titus Ulke speaks of electrolytic nickel:—

In the commercial electrolysis of nickel, even with anodes containing as high as 96 per cent. of nickel, the anodes readily fall to pieces, owing to their uneven solution. A large quantity of anode scrap is formed, often as much as 50 per cent.; this difficulty increases when matte anodes are used. — COWPER-COLES.	In the commercial electrolysis of nickel, even with anodes containing as high as 95 per cent. of nickel, the anodes readily fall to pieces, owing to their uneven solution, and a large quantity of anode scrap, often as much as 50 per cent. of the charge is produced. . . . . The difficulty increases when matte anodes are employed.—TITUS ULKE.

One example more, which shows a strong family likeness between what Mr. Cowper-Coles has written, and an extract from *Mineral Industry* for 1898, page 141:—

Askermann has tried fusing chromium oxide and antimony sulphide, below the fused crust of sulphides which is formed, a crystalline mass of the two metals occurs, the antimony being finally removed by oxidation or refusion. The addition of sulphides is considered to accelerate and facilitate the metallurgical reactions.—COWPER-COLES.	Ashermann fuses chromium oxide and antimony sulphides. The crucible afterwards contains, under a crust of sulphides, a crystalline mass of the two metals; the antimony can then be removed by oxidation or refusion. Ashermann thinks the addition of sulphides in general advisable, in order to accelerate and facilitate metallurgical reactions.—*Mineral Industry*.

I will not call this plagiarism; I prefer to suppose that Mr. Cowper-Coles some time ago scribbled some notes on loose slips and forgot to quote the source of his information. If so, he will really be surprised when he reads this, because he very likely thought he was the author of his "Notes on the Recovery and Refining of Nickel."

Pertinax.

Cowper-Coles Electrolytic Cyclic Process.

With reference to the question of priority of use of the revolving cathode, raised in the discussion in your last week's issue, I think Mr. Cowper-Coles will not have the slightest difficulty in proving Dr. Tommasi's patent of 1892 to have been anticipated, as this device was employed in 1889 in a South Wales smelting works for the deposition of gold in bullion refining.

W. Gibbings.

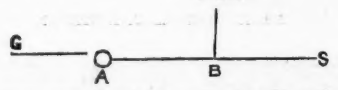
December 30th, 1898.

Shocks.

Can any of your readers give me an explanation of the following circumstances:—On the afternoon of December 24th, about 2.30, something went wrong with our lighting and we found there was a leak of abont 20 amperes at 1,100 volts.

The generating station is about two miles from the town of Limavady and the line is entirely overhead, except at three points. At these places it runs underground in a trench 2 feet deep, and is India-rubber covered cable armoured with galvanised iron wire.

I give a diagram of the connections. A is a transformer station, a wooden house above ground; B a junction with a



G, From generating station; S, To other sub-stations.

feeder lately laid down. Between A and B the line was underground for 50 or 60 yards. This distance is grass lawn and gravel entrance drive of a residence.

On walking over this place near where the line is buried distinct shocks could be felt and numerous earth worms were rising to the surface.

There had been heavy rain, and the ground was very wet.

Can any of your readers explain why shocks should be felt on the surface?

Of course, one of the wires was leaking to earth, and it may be that there was a fault on the other cable at one of the other places where it is buried; but I cannot understand why anyone standing on the ground should feel a shock. Both cables are in the same trench, 5 or 6 inches from one another.

I see birds sitting on the bare wires while the current is on, sometimes thousands of starlings literally cover the wires, and it seems to do them no harm.

I may mention that as it was getting late we simply cut out the cables between A and B, which remedied matters for the time.

J. E. Ritter.

Limavady, *December 26th*, 1898.

Trolley Pole Ropes.

In reference to the regrettable accident which occurred on the Halifax electric line on the 22nd ult., the question may

well be asked, Is it necessary for cars to have ropes continually hanging from the trolley poles? they not only appearing unsightly, but beyond all doubt a danger to passengers.

I would like to direct the attention of engineers and tramway managers to the running of the electric cars at Bristol, which have been in operation for over three years. Here the trolley ropes are hung up to the poles and standards immediately the cars leave the depot, and are only unhooked when it is necessary to change the trolley to another wire at the end of journey. Assuming the trolley jumps the wire at any point, no possible danger need be feared, as (from the peculiar construction of the trolley head) it simply glides under the bracket arm or span wire as the case may be, until the car is brought to rest.

It is, therefore, to be hoped that tramway managers will copy the example set at Bristol, and insist upon all ropes being attached to the trolley standard, when a recurrence of a similar accident will be entirely obviated.

Pro Bono Publico.

Re Brighton Breakdown.

Owing to the pressure of business and the intervention of the holiday, I have been unable, until now, to reply to "H. C. L.'s" letter in your issue of December 23rd.

When I penned my first letter, I had no intention of allowing myself to be drawn into a prolonged correspondence, as I have not the requisite leisure to do the subject justice. This must be my excuse for withdrawing from the discussion at this point, and also for declining to enter into a detailed explanation as to how to reconcile the facts with the characteristic curve. At some later date, should you consider it of sufficient interest and time should permit, I shall be glad to deal with the subject at greater length, and also to give some particulars as to how we propose to prevent the recurrence of such a mishap.

For the present, however, I must be content with a brief reply to the other points raised in "H. C. L.'s" letter.

First let me assure him that we are in perfect accord as to the meaning of the characteristic curve.

I must apologise for having mis-read the paragraph in his letter relating to demagnetisation, but if his remarks, as explained, are true, I am quite at a loss to understand how a self-excited shunt machine can ever run down to zero much less actually reverse, and some considerable modification of the usually accepted theory will have to be made.

With reference to the "penultimate" paragraph of my previous letter, I must explain that this was *not* intended as a proof that such effects exist (a fact which unfortunately requires no proof) but as a reply to the statement made by "H. C. L." in his letter of December 9th, which ran as follows:—"A properly-designed shunt dynamo, if run up to speed with its terminals short circuited (and therefore giving no volts) will, if the resistance between the terminals be suddenly increased to its normal full load value, immediately take on its full output more or less rapidly."

I would point out that the conditions mentioned in this paragraph do not form a parallel to the Brighton case, unless it be assumed that the dynamo is started up with the brushes in the *full load* position, in which case the statement is clearly in direct opposition to the facts.

Like "H. C. L.," I am only desirous of arriving at the true cause, and if my explanation is insufficient, I shall be only too glad to see a better substituted.

In conclusion, I would like to express my appreciation of the courtesy with which "H. C. L." has criticised my views, our differences notwithstanding.

Wm. C. P. Tapper.

The Deposition of Copper.

The process advocated by your correspondent "Lux" for the deposition of the tubes, &c., having for its object the discarding of burnishers, was in use at the Anaconda Works some two or three years ago, but has, I believe, been discarded.

W. Gibbings.

December 30th, 1898.

REVIEWS.

Practical Calculation of Dynamo-Electric Machines. By ALFRED E. WIENER. New York: W. J. Johnston Co.

We learn from the preface that the aim of the author has been to make this book thoroughly practical, and with this in view he has therefore departed from the time-honoured custom of filling a large part of his available space with chapters on the theory of magnetism, electro-magnetic induction, &c., and has restricted himself entirely to the calculations necessary for the design of dynamos of various types. The tables and formulæ which form the basis of these calculations have been derived from the data and tests of over 200 of the best modern dynamos of American and European make, and the author claims that whereas the application of the formulæ given usually in text-books requires more or less experience in dynamo design to be successful, his treatment gives this practical experience, and should enable anyone with a knowledge of arithmetic and algebra to successfully calculate and design any kind of continuous current dynamo by means of the tables and formulæ provided in this book. This claim is a very bold one, and we should be doubtful of the result of entrusting the design of a large dynamo to anyone whose knowledge did not extend beyond what could be learnt from a book, however good that book may be; as it appears to us impossible to provide formulæ to meet all the varying requirements that are met with in dynamo design. Indeed, we have only to turn to the examples of the design of machines given by the author to find that the exact values of some of the constants are not fixed by a hard and fast law, but vary between certain limits, and that the designer has therefore to make a choice which may or may not lead to a satisfactory result. Whilst thinking that in this respect the author is claiming too much for what he calls the practical treatment as opposed to the theoretical treatment given in many text-books, we consider that the tables in this book give a very large amount of useful information which should be of great value to anyone who has already some practical experience in the design of dynamos.

The author divides his book into eight parts, the first of which is introductory and treats briefly of the production of electromotive force, the collection of commutated currents, and the different ways of winding the armature, and of exciting the field. In Part II. the author proceeds to the calculations of the armature, first determining the length of active conductor, then its sectional area and dimensions, then the diameter of the core and its length and radial depth. To obtain the length of active conductor, reference is first made to tables which give for machines of various types the percentage of the circumference which should be embraced by the poles; the best peripheral speed according to the output of the machine in kilowatts, and whether it is belt driven or direct driven and has a drum or ring armature; the most suitable field density in the air gap for machines of different outputs according as they are bipolar or multipolar, and have smooth, toothed, or perforated cores; and the values of what is called the armature induction or volts generated per unit length of wire cutting unit field at unit speed for different percentages of polar arc. The values found in these tables are then inserted in the formula which gives the length of active wire in terms of the armature induction, the peripheral speed, the field density, and the E.M.F. to be generated. The size of the conductor is settled by choosing a current density which is left very much to the experience of the designer, as the author only fixes an upper and a lower limit, and gives but little guidance as to when one should approximate to one or the other value. The mean winding diameter of the armature is calculated from the peripheral speed and the revolutions per minute and the diameter of the core is obtained from it by subtracting the depth of the winding, values of which for different outputs are given in tables. The circumference and depth of winding being fixed, the number of wires per layer, and the number of layers that can be got into this space are found, reference having again to be made to tables which give the allowances that should be made for insulation, binding wires, driving strips, clearance, &c. The length of the core is found by dividing the length of active wire by the number of wires on the armature, and the radial depth of the core is then fixed by calculating the total magnetic flux through the

core, and dividing this quantity by twice the core length, by the ratio of net to total sectional area (values for different thicknesses of discs and methods of insulation are given in a table), and by the magnetic density, the best values of which are found by reference to another table.

The methods adopted in calculating the leading particulars of the armature have been given at some length, as they indicate very well the principles of the treatment throughout the book, all calculations being made by means of formulæ, the constants required for which are found by reference to tables, in which their average values, deduced from the data of existing machines, are given. In similar manner, tables and formulæ are given for determining the total length and weight of wire on the armature, armature resistance, hysteresis and eddy current losses, effective cooling surface, and rise of temperature in the armature, drag on the conductors, energy losses due to friction and contact resistance of brushes, and the diameter of shaft, diameter and length of journals, and other mechanical data of the armature.

Parts III. and IV. deals with the calculations of the magnet frame, and contain a number of tables and formulæ for determining the coefficient of magnetic leakage, with examples of their application to magnetic frames of various types, and for fixing the best proportions of magnet limbs and pole pieces of different materials, and of non-magnetic supports for attachment of the magnet frame to the bedplate. Part V. treats of the relation between magnetomotive force and exciting power, and shows how to calculate the ampere-turns required for the core, air gap, and field magnets, and for compensating the armature reactions; and Part VI. shows how to determine the magnet winding, which will give the predetermined number of ampere-turns. Part VII. gives data and formulæ for calculating the efficiency of dynamos and motors, rules for applying the formulæ for dynamos to the calculation of motors, with notes on the design of dynamos and motors for special classes of work, rules for the calculation of unipolar dynamos, a description of the methods proposed by Ryan, Sayers, and Elihu Thomson for the prevention of armature reaction, and a chapter on dynamographics dealing with characteristic curves and the manner of using them to solve various problems graphically.

Part VIII. is devoted to practical examples of dynamo calculation, and gives in detail the working out of the design of several smooth and toothed core bipolar and multipolar dynamos and motors, and also examples of the calculation of the leakage factors of various dynamos, with a comparison of the calculated results with the actual leakage factor as determined by tests on these machines. We notice, in looking through these calculations, that higher temperature rises are allowed than would be accepted in England, and that the method of design appears to lead to very various temperature rises in different cases, and that the peripheral speeds of ring armatures are in some cases very high—notably in a 10-pole inner-pole 1,200-kw. dynamo, in which, as designed by the author, the circumferential velocity of the conductors on the outside of the core is as high as 115 feet per second. There are few signs to indicate that the data of modern English machines have been much used in compiling the tables, and in matters of construction the English designer will note differences, such as the greater use of cast-iron pole pieces, the use of wire-wound drum armatures of large output where in England a bar drum with compressed strand bars would be used; but he will also find a great many data concerning slotted core armatures which should be of service to him, and which we believe will not be found in any English text-book on dynamo construction.

Dizionario Tecnico in Quatro Lingue. Milan: Ulrico Hoepli.

We recently noticed three volumes of a set of four, constituting a polyglot vocabulary of technical terms in English, French, German, and Italian. Each volume contains equivalents in the four languages arranged in parallel columns, the first column, which is of a different language in each volume, being arranged alphabetically. We have now received the fourth volume, that in which the English terms are arranged alphabetically, with their equivalents in parallel columns, which will generally be the most useful to English engineers. The terms are very numerous, and for the most part accurate, and the size and form of the volume is convenient for handling. The English editing has been done in this case with more care than in the others.

ELECTROLYTIC DECOMPOSITION OF AQUEOUS SOLUTIONS.

One of the most important papers which we have ever read on this subject has recently been published in serial form in the *Zeitschrift für Elektro-Chemie*, Vol. iv. (1898), pages 355-359, by L. Glaser, who has made an extended series of experiments to obtain more precise information with regard to the electromotive force necessary for the electrolysis of aqueous solutions, and the results are described in three parts.

I.—The Formation of Water in the Gas Battery (HO Cell).

In these experiments platinised platinum electrodes were used, and the gases, oxygen and hydrogen, were led over them in a continuous stream. Different electrolytes, comprising acids, bases, and salts, were employed, and it was found that the mean value of the electromotive force of the battery was 1·08 volt. Certain salts, however (with the exception of those—*e.g.*, aluminium sulphate, &c.—which react acid in solution), occasionally gave slightly lower values, as has already been observed by Smale (*Zeitschrift für Physicalische Chemie*, 1895), but these low values disappeared on making the electrolyte slightly acid or alkaline. Also, certain solutions which, on electrolysis, do not evolve pure oxygen and hydrogen, gave in general lower results. The normal E.M.F. of the battery is only obtained after a lapse of four or five hours; and it was proved by measuring the potential of each electrode against a normal electrode, that this sluggishness in attaining the normal value is due almost entirely to the oxygen electrode. This is further ascribed to the low absorptive power of platinum black for oxygen. A minute quantity of hydrogen peroxide added to the electrolyte causes the battery to assume its normal E.M.F. in a shorter time; large quantities, on the other hand, produce a lowering of the E.M.F., due, probably, to secondary reactions. It is also noteworthy that the final value is in general reached much quicker with bases than with acids.

As regards the capacity of the cell, it was found, on taking a current of $1·8 + 10^{-4}$ amperes from an ordinary gas battery filled with a normal solution of caustic soda, that the voltage fell in 300 minutes from 1·080 volt to 0·914 volt, where it remained fairly constant.

On breaking the circuit, the voltage gradually rose, and attained its original value after two hours' regeneration. When heavier currents were taken from the cell, a greater fall in voltage occurred, and each current strength corresponded to a lower limiting value of the E.M.F. For example, the following values were obtained:—

Current taken, $2·3 + 10^{-4}$ amperes; voltage fell to 0·760 volt in 300 minutes.

Current taken, $4·2 + 10^{-4}$ amperes; voltage fell to 0·463 in 80 minutes.

From these results it follows that the gas can only diffuse very slowly into the electrodes, and that for each current strength a point of equilibrium is reached when just as much gas diffuses into the electrodes as is removed as water during the reaction which takes place. The E.M.F. of the gas battery diminishes with rise of temperature, and it was found from measurements with six different solutions that the mean value of the temperature coefficient was 0·00143, whereas Smale obtained the value 0·00146. In accordance with the osmotic theory, it was found that an increase in the concentration of the electrolyte produced a slight but perfectly definite increase in the electromotive force of the gas battery. The substitution of organic liquids from the ordinary electrolytes generally gave low and very inconstant results. Thus far the above experiments confirm the law enunciated by Smale, viz., that the formation of water in the gas battery is a reversible phenomenon.

II.—THE DECOMPOSITION OF WATER.

Hitherto, practically, all observers agree in assigning about 1·67 volt as the lowest E.M.F. necessary for the electrolysis of acidified water, but between this value and the E.M.F. of the gas battery there exists the large difference of 0·59 volt. In order to throw some light on this apparent contradiction, the next series of experiments was undertaken.

The P.D. between platinum electrodes dipped into acidified water, was gradually increased from zero upwards, and the intensity of the current which passed through the cell at each stage, measured by means of a very sensitive galvanometer. It was found that a greater increase in the deflection of the galvanometer took place about 1·08 volt, and it was also noticed that there were certain irregularities at about 0·5 volt—0·6 volt. At 1·08 volt, therefore, a continuous but perfectly distinct electrolysis goes on, which, on account of its relative insignificance has hitherto escaped the notice of observers. It is thus shown directly that the formation and decomposition of water is a reversible process. The further discussion of the curve obtained by plotting the strength of the current against the E.M.F is to be found in Part III. In the first experiment two bright platinum electrodes, which did not differ very much in size, were used, and the interpretation of the curve obtained, was rendered more difficult owing to the summation of the effects of polarisation. To overcome this difficulty, first the anode and then the cathode was made non-polarisable by making it relatively very large. The electrodes actually used consisted of a sheet of platinised platinum foil with a surface of 20 square cm., which was always exposed to the air before being introduced into the cell, and a small piece of platinum wire sealed into a glass tube and having a superficial area of 4·7 square mm.

In order to make sure that the potential of the large electrode with respect to the solution remained constant throughout the experiments, a large working lead electrode coated with peroxide was used in some cases, and the values so found referred to the platinum electrode. The following table will serve to illustrate the results obtained when the small electrode was the cathode. The deflections of the galvanometer, n_1, n, and $n\,m$, are recorded immediately after making connection, then after the lapse of half a minute, and finally after one minute. Each millimetre deflection corresponds to a current of $1{\cdot}14 + 10^{-9}$ amperes. Although the amplitude of the deflection varies with the time, analogous curves are described, and the point at which decomposition begins does not change.

It will be seen from the table that a small current, probably a convection current, begins to pass at 0·200 volt and remains of the same order of magnitude up to the point of decomposition, when there is a sudden and unmistakable increase in the intensity of the current, showing that the electrolysis has set in. The same irregularity is noticeable about 0·5—0·6 volt, when the different quotient $\frac{d\,i_2}{d\,e}$ actually becomes negative. On repeating the experiment after 0 7 volt had been reached, this irregularity disappeared, and the curve remained practically linear and parallel to the abscissæ axis up to 0·6 volt. The point at which electrolysis begins, viz., 1·08 volt, is nearly independent of the concentrations of the acid.

Volt.	n_1	n_2	n_3	$\frac{d\,i_2}{d\,e}$
0·050	0 00	0 00	0 00	...
0·200	0 10	0 00	0 00	0 0
0 265	0·20	0·10	0·10	1 5
0 350	0 70	0·60	0 60	5 9
0·420	1 30	1·25	1 25	9 3
0·515	1·70	1 45	1·25	2·1
0·550	1·50	1 20	1·10	−7 1
0 655	1·70	1 40	1·35	1·9
0·750	2 00	1·70	1·55	3 2
0·800	2·15	1 82	1 65	2·4
0 848	2 30	1 95	1·75	2·7
0·900	2 40	2 02	1·95	1·4
0 982	2·50	2·10	2 00	1 0
1·020	2 90	2 50	2·30	1 1
1·100	27·00	17 00	13 20	181 0
1·170	56·40	44 00	38 50	385 0
1 285	92 80	81·80	77 20	330·0

(To be continued.)

METHODS OF CHARGING FOR ELECTRICITY IN AMERICA.

BY R. S. HALE and J. S. CODMAN.

ALTHOUGH the consumption of electrical energy to-day is from three to four times as extensive in proportion to the population in America as it is in the United Kingdom or on the Continent, yet the methods of selling have not come into such standard forms as they have on our side, and a brief account of the various methods used in selling electricity in America may be of interest.

In the earliest days practicable electricity meters were not known, and the form of charging was a fixed sum per month, called contract or flat rates, and this method has since developed into the following:—A fixed sum per month per lamp connected, independent of the use. This is usually from $1 to $2 per month per 16-C.P. lamp.

A lower price is frequently charged, on condition that the lamp is used only between certain hours. Thus from the list of charges of one company we find that the price per 16-C.P. lamp, burning from dusk until 8 o'clock on week-day nights, is 56 cents per month; from dusk until 10 o'clock, 70 cents; and from dusk until midnight, 90 cents; and all-night lamps, $1 25 cents. All lamps may burn till midnight Saturdays, but an extra charge is made for Sunday use.

Companies that use this method seldom give more than the night's supply, shutting down their stations from dawn until dusk. Inspectors patrol the streets occasionally to see that lamps are turned off at the proper times, while private house lighting is taken either at special or all night rates.

In other cases the charge is based, not on the number of lamps connected, but on the estimated number of lamps that may be lit at one time; thus, in one of the suburbs of Boston the charge is $6 per lamp per year, the number of lamps being the maximum number supposed to be lit at one time independent of the number connected.

In other cases the number of lamps is taken from the rated size of the transformers where house-to-house transformers are used.

In other cases still, the maximum number is limited by the size of the fuse, *i.e.*, a customer pays according to the rated capacity of the fuse, or a Wright meter is used for ascertaining the maximum demand.

In other cases the price per lamp depends on the business of the customer, thus lamps in stores (anglice shops) are charged at one rate and lamps in private houses at another rate.

In still other cases the fixed sum to be paid per month is purely a matter of barter between the central station and the customer, the central station agreeing to light the house or store or hotel for a fixed sum per month, and taking its chances that the customer will not use more light than he pays for.

While at first the contract system was a necessity, and while it has continued to a great extent even to this day, owing to the fact that it is simpler than the meter system, satisfies the customer better and avoids the expense of meters, yet it was early recognised to be inherently bad, since it placed no check on the waste of current.

The necessity of competition with gas early brought the electric meter into use. At first the method of charging by meter was similar to the method of charging for gas, viz., a fixed price per unit of electricity, or per lamp per hour, with discount for prompt payment or for large bills.

The essential difference in manufacture between gas and electricity caused this system to have very vicious effects on the business of the electric companies, since a large lamp connection used only a few hours per month became a source of loss instead of profit.

One of the first methods to avoid this was, to insist on a minimum payment per lamp per year; thus, for a long time one of the large Edison companies refuse to connect any lamps unless they were guaranteed a payment of $4 per lamp per year. Other companies have since adopted the same or similar systems, alternating companies frequently basing the guarantee on the rated capacity of the converters, where house-to-house converters are used, and a few companies basing the guarantee on the size of the fuse, which limits the maximum number of lamps that can be used at the same time. The requirement of a guarantee payment per lamp avoids the danger of taking on customers who are a loss instead of a profit, and does not take account of the fact that long hour customers can be supplied at a very much lower rate than short hour customers; in order to meet this condition, several companies introduced a scheme of long hour discounts, generally based on the connected load; thus, for instance, in Boston at one time contracts were offered, giving a discount of 5 per cent. to customers who used their connected load 50 hours per month; 10 per cent. if they used it 75 hours per month, and by increasing steps, until a customer who used his connected load over 300 hours per month received a discount of 35 per cent. off the base price. This system, of course, did not meet the case of private houses, bar-rooms, hotels, &c., which wished to connect many more lights than they would use at any one time, and the demand indicator has been introduced in a number of companies to meet the case. Other companies have tried curious expedients to avoid this, for instance, one company estimates a customer's demand in proportion to the number of rooms in his house, charging a high price until the consumption amounts to a certain number of kilowatt-hours per room, and a low price for any additional current. Other companies have allowed the customer to estimate his demand, and have put in a fuse so that in case he exceeds his demand, his light is cut off, rather to his dissatisfaction.

Another system has been to charge a fixed sum per lamp per month and an additional sum for all current used, thus one of the Western

town charges 30 cents per lamp per month and 5 cents per kilowatt-hour for all current consumed, this, of course, being the practical equivalent of the original Hopkinson system which naturally involves the annoyance and expense of domiciliary visits from time to time to check the number and candle-power of the lamps fixed throughout the house. The Niagara Falls Power Company has advertised its power in the same way, charging $1 per kilowatt per month for the maximum demand, and a rate varying from ¼ cent to 2 cents per kilowatt-hour for all current actually used.

Still another method of giving low rates to long hour customers is the method used in many large cities of making a special price, this price depending on the estimated maximum of the consumer and on the current consumption; thus, for instance, the central station manager will estimate the customer's maximum at 100 kilowatt, and will offer him a price of, say, 8 cents per kilowatt-hour, provided the customer will guarantee to pay $1,000 per month, corresponding to a certain use of this estimated maximum. If the customer will guarantee a longer use of the same installation he gets a lower price. The actual price often depends on the skill in bargaining of the parties, rather than on the cost of the central station.

It is, of course, understood that no one company is using all, or nearly all, the different methods of charging described above, while, on the other hand, there is but one company that has even the reputation of sticking to its published rates. In general the companies publish a set of rates, but, as a matter of fact, are willing to make special contracts in special advantageous cases.

The general trend of events is, however, very clearly towards some sort of sliding scale, based on the actual ascertained maximum demand, and methods essenially founded on the Wright system have met, so far, with much the greatest success. The chief difficulty at first in applying the method to American conditions is the fact that bills are almost invariably rendered monthly, and in some cases even weekly, whereas the maximum demand occurs only once a year; this point has, however, been provided for. It is safe to say that there are no companies that are working from a sliding scale towards a fixed meter rate, while a number of companies have adopted sliding rates based on maximum demand. The majority have, in adopting the maximum demand basis, made the first rate higher than their present rate, and the second rate lower, although there are a few exceptions; thus Chicago, which formerly charged 20 cents per kilowatt-hour, is now charging 20 cents for the first hour and then 10 cents; Boston, which formerly charged 18 cents, is now charging 20 and then 8 cents; Cambridge, which formerly charged 14·4 is now charging 20, and then 6 cents; Cleveland is charging 12 cents for two hours' use, and then five (5) cents; Edison Sault is charging 16 cents and then 4 cents; Detroit 16 and then 4 cents, and Trenton 14 and then 8 cents. New York is charging 20 cents for the first hour, and then different rates for the second, third, and fourth hours' use, down to 5 cents per unit.

While the systems of charging in America are not, as may be seen by the above, in any way standardised, yet the tendency towards some sort of sliding scale, based on the ascertained maximum demand, is very marked.

BUSINESS NOTICES, &c.

Agency.—Mr. George W. Webb, of 153, Leathwaite Road, S.W., has been appointed sole representative of London for Messrs. H. W. Sambridge & Son, Highgate Street, Birmingham, manufacturers of chandeliers, gas fittings, electric light fittings, &c., in brass and wrought-iron.

Announcements.—We are informed that Messrs. E. M. Lawrence and A. J. Hanson, of Sydney, N.S.W., have purchased the business of Alfred Lawrence, electrical goods importer, and agent for the General Electric Company, Limited, and the London Electric Wire Company, Limited, of London, and will in future carry it on under the name of Lawrence & Hanson, at 3, Wynyard Street, Sydney; all liabilities of the said business are to be discharged by them.

The Edison & Swan Company have recently laid down further special plant to enable them to cope with the increasing demand for their new Type F. instruments. These instruments were recently introduced to meet the demand for a really reliable instrument at a moderate price. The case is cast-brass, and the dial is silvered and engraved (not painted). All bearings are jewelled, and the greatest care is taken in calibration. The company are holding large stocks of all standard ranges.

Messrs. Donnison, Berlyn, Sillem & Co., of London, have removed their North of England branch offices and showrooms to more extensive premises at 66, South John Street, Liverpool. This branch will remain, as before, under the management of Mr. H. Ellis Thompson. The firm's London general manager, Mr. B. Garland Matthews, has been ordered by his doctor to change his residence for South Africa on account of continued ill-health, and has consequently been compelled to resign.

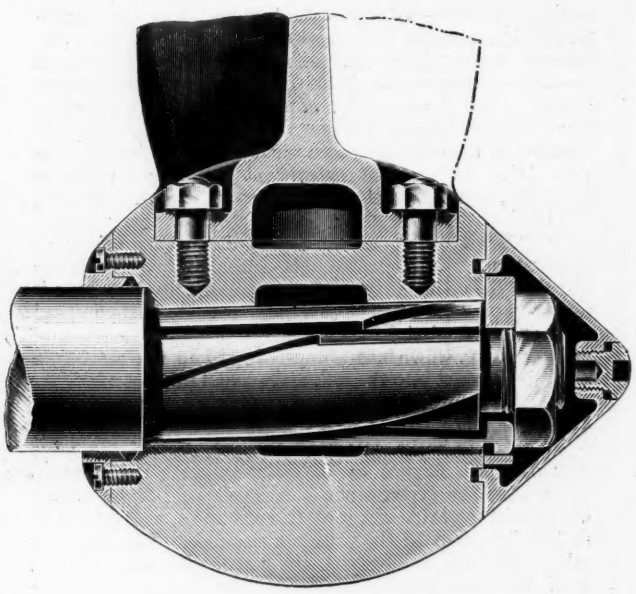
Mr. E. H. Johnson, who was formerly with the British Blahnik Arc Light Company, has, we are informed, been engaged by Messrs. Donnison, Barber & Co., of Manchester and Nottingham.

Annual Dinners.—The annual dinner of the staff of the electrical department of the North Staffordshire Railway was held at Stoke-on-Trent on 29th ult. Mr. John Neale, electrical engineer, presided.

The London office staff of the National Electric Free Wiring Company, Limited, held their first annual dinner at the Holborn Restaurant on Friday, 30th ult. A number of visitors were present, and a most enjoyable evening was spent. The manager, Mr. B. H. Jenkinson, was in the chair, the vice-chairman being the secretary, Mr. Percy B. Wilson.

Auction Sale.—On Tuesday next Messrs. Furber, Price and Furber will offer for sale by auction, at 77, Chancery Lane, certain electrical plant. See our small advertisements for particulars.

Ballot's Patent Propeller and Shaft Coupling.—We illustrate below this system of couplings, which is the invention of Mr. John Ballot, of Cannon Street, E.C. The couplings are adapted for fixing in position driving pulleys, fly-wheels, main shafts, screw propellers, and for many purposes where a coupling is required which is secure in every direction and at the same time readily attachable and detachable. The application to a propeller boss and shaft is shown in the illustration. In this case a thin nut and a washer are



provided on the reduced end of the shaft, to retain the keys in position, the hooked heads of the keys being sunk in slots in the washer, and the whole covered by a neat cap, which is filled with oil through the plug shown in the end. Obviously, the coupling would be also very advantageous in cases where two or more propellers are required to be fixed on one shaft. The arrangement with taper keys is also applicable to shaft couplings. Further particulars of the coupling may be obtained from Messrs. Denne and Simpson, consulting engineers, of 28, Victoria Street, S.W.

Book Received.—"Proceedings of the Municipal Electrical Association, 1898." 3s. 6d.

Calendars and Lists.—Messrs. W. H. Willcox and Co., Limited, have sent out one of their usual wall date remembrancers for 1899.

Messrs. Croggon & Co. have also issued one of their handy-sized wall calendars for the current year.

We have received from Messrs. W. Liley & Co., of Liverpool, a small office paper-knife.

An 1899 calendar with monthly sheets has been issued by Messrs. Hodges & Todd, Limited.

The Cruto Incandescent Lamp Ageney, Limited, of Billiter Street, E.C., have issued some lists giving prices and sketches of Cruto lamps of various sizes and voltage.

A convenient little blotter with 1899 calendar comes to hand from Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne.

Changes of Address.—Mr. W. C. C. Hawtayne notifies that he has removed from 20, Bucklersbury, E.C., to 9, Queen Street Place, London, E.C.

Messrs. Crampton & Co., electrical engineers, have just removed from Regent Road, to 25, Regent Street, Great Yarmouth.

Dissolution of Partnership.—Messrs. Boyd & Alcock, electrical engineers, Willesden House, Llandudno, have dissolved partnership by mutual agreement. Mr. Alcock is carrying on business on his own account at the above address.

Electric Driving at Cardiff.—When extending his cardboard box manufactory last year, Mr. Thomas Yates, of Cardiff, introduced electric motors for driving the machinery. The installation was put down by Mr. Sydney F. Walker, and current is taken from the Corporation mains at 2½d. per unit. The working cost comes out less than for gas, and the trial has demonstrated the convenience of application of the electric motor.

Electrical Work in Russia.—It is said that the Compagnie Centrale Electricite, at Moscow, is about to increase its capital from $300,000 to $2,000,000 in order to take charge of the Russian affairs of the Compagnie International d'Electricite, of Liege, which

are to establish large electrical engineering works in Russia. Fully 50 per cent. of the last-named sum will be employed in the purchase of new machinery and the latest improved apparatus for the works. *Sell's Commercial Intelligence* advises English electrical engineers and tool makers to take a note of this.

India-Rubber.—Messrs. Jackson & Till's January statement gives the India-rubber stocks for the United Kingdom at 2,109 lbs., as against 1,376 on January 2nd, 1898, and 1,992 in 1897.

Municipalities and Electrical Monopolies.—The town clerk of Huddersfield (Mr. F. C. Lloyd) has addressed a letter to Mr. T. Farrow on the subject of the General Power Distributing Company's Bill, Mr. Farrow having entered upon a crusade on behalf of the municipalities. Mr. Lloyd recommends all municipal authorities to oppose the scheme, whether they are within the company's area or not, as the question may ultimately affect them.

Messrs. B. Cabella & Co.—We mentioned last week that the Italian firm of Cabella & Co., of Milan, had been formed into a company, under the name of Tecnomasio Italiano, for the execution of all kinds of work connected with electrical industries. The firm has established an excellent reputation in Italy and elsewhere for the construction of electrical machinery and appliances, scientific instruments, &c. The capital is £2,000,000, divided into 20,000 shares of £100. Signor B. Cabella has been appointed liquidator, with full power to act, and he will arrange for the completion of all orders now in hand and for the winding up of the affairs of the firm. All future orders will be executed by the company, Tecnomasio Italiano.

National Electric Free Wiring Company.—We understand that this company have secured the contract for the complete incandescent and arc lighting of the Preston Electric Railway and Tramway Carriage Works, Preston. The order for the complete plant and wiring of Messrs. Margetson, Welch & Co.'s premises in Long Lane, Bermondsey, has also been placed in the hands of this company, who are also now carrying out the electric lighting of the Cooper's School of Art at Canterbury, and the installation of electric motors in Messrs. Lovibond's Brewery at Greenwich.

Scotch Water-Power Scheme.—Referring to the Loch Leven water-power electrical scheme, the *Daily Chronicle* says that it is proposed to incorporate and confer the necessary powers on the Highland Water Company, and amongst the noblemen and gentlemen who are mentioned in connection with the undertaking are the Earl of Crawford and Balcarres, Lord Tweedmouth, Lord Kelvin, Wm. Macbean, Provost of Inverness, and Colin Young, Provost of Fort William. The company propose to take powers to provide water, under pressure or otherwise, for the purpose of supplying motive power and to supply and use such power for any purposes to which it is or may be applicable; to generate, use, and supply electrical energy for any purposes to which such energy is or may be applicable; to erect, lay down, and maintain any buildings, works, and apparatus which may be necessary to acquire and work any patents relating to the supply of water and motive power, and to the generation, storage, supply, distribution, &c., of electrical energy, and within the area of supply to serve any person with water-power, motive power, and electrical energy on such terms as may be agreed upon. Powers are given to construct embankments, aqueducts, tunnels, &c., and by means of their waterworks to take, appropriate, impound, and store the waters of the River Ericht and Loch Ericht, and a number of streams flowing into them, also other waters and streams. A limit is placed on the extent to which the level of Loch Ericht may be raised or lowered. The proposed capital is £1,000,700, with borrowing powers.

Electric Clocks.—The Great Eastern Railway Company are installing a complete circuit of electrically worked clocks at Liverpool Street station. Under the station roof one immense clock is fixed, which is controlled from the telegraph engineer's office, and in turn it operates the whole of the smaller clocks on platforms, in booking halls and offices. The hands move five times each minute, and as the large clock is about 50 feet high and over the railway lines, there has been provided to gain access to it one of Heathman's patent telescopic tower ladders. A similar one has been working well for about three years at the Brompton Oratory.

1898.—Messrs. Hill, Gifkins & Co. report that they have been so busy during 1898 that they have been compelled to take additional offices and stores in Victoria Street. Within the 12 months they have carried out 158 installations, comprising transmission of power, mill, yacht, country and town houses, and public house lighting, and they have in hand a large country house installation and several public houses and town houses at the present time. They report a good sale for the patent H. & G. high tension main switch, also for their telephones and arc and incandescent lamps.

Messrs. Hodges & Todd, Limited, report a very successful year. Their new high tension fuseboards, switches, and cut-outs have met with universal approval, whilst their work in large switchboards, instruments, and central station apparatus of all kinds has shown a great increase on previous years. The firm have again found it necessary to extend the works to cope with increased trade.

ELECTRIC LIGHTING NOTES.

Aberdovey.—The Towyn and Aberdovey electric lighting scheme proposed by Col. Ruck was before the Council last week, and was favourably received. A canvass of the districts is to be made.

Armagh.—At the recent meeting of the County Armagh Asylum Board, the matter of appointing an electrical engineer to look after the electric plant, &c., in the new buildings at the Asylum, came up for consideration, and after some discussion, it was decided to appoint an electrical engineer. This is stated to be the only public building in Armagh which has taken up the use of electricity, and it is hoped its success will lead to more of the buildings trying the experiment.

Ayr.—On 30th ult. the blowing of a fuse in the Hope Street sub-station caused a temporary short circuit, and blew the main works fuse. For about half an hour there was a failure of the light on circuit No. 1.

Belfast.—On 27th ult., according to the *Belfast Evening Telegraph*, something went wrong with one of the street main connections, and a number of horses received slight shocks, bringing them to the ground. The city electrical engineer's staff promptly put matters right.

Calcutta.—Messrs. Kilburn & Co., who have been entrusted with the electric lighting of the town, have put down a plant for 60,000 lamps for supplying the area within Circular Road. The supply, says the Delhi *Morning Post*, will be continuous throughout the 24 hours. The plant laid down consists of three boilers of 500 H.P., which could be extended to 800 H.P. if necessary, eight dynamos, and a storage battery. Messrs. Kilburn expect to have everything completed this month. The central works have been erected in Emambagh Lane.

Camborne.—The District Council have decided to support the application of the Camborne Electric Lighting Company for a provisional order.

Chelmsford.—At the last Council meeting the town clerk reported that he had written to the Chelmsford Electric Lighting Company with regard to the complaints as to the lighting of the town, and also with regard to the private lighting, and he had received a reply, stating that the company were aware there had been extinctions of the lights at times. This was due to accidents at the lighting station. Extensive alterations at the generating station, and with regard to the distributing system, were also being carried out. As for the private lighting, the company considered the charges made as to its insufficiency to be somewhat vague. In nine cases out of ten when complaints as to private lighting were investigated, the bad light was found to be due to defective fittings in the house or to the fact that the consumer had put extra lamps in the house without notifying the company. The town clerk also reported that he had written to the lighting company complaining of the manner in which the paths and roads were broken up in laying down the cables, and had received a reply expressing regret that such a complaint should have to be made, and stating that the letter had been forwarded to Mr. A. H. Pott, the engineer in charge of the cable laying. The matter was referred to the Lighting Committee.

Derby.—After considering a report by the electrical engineer, Mr. T. P. Wilmshurst, as to buildings and plant extensions to meet increasing demand for current, the Electric Light Committee advise that certain land adjoining the present station be acquired, that structural alterations and additions to the buildings be made at a cost of £25,000. In this estimate provision has been made for utilising the works for supplying power for working the tramways. The committee advises that application be made to the Local Government Board for a loan.

Doncaster.—The architect of the new workhouse recently invited tenders for the electric lighting of the buildings, but the guardians say that he did this on his own account, without their instructions. The guardians had a brief discussion last week, and the matter will probably come before the Workhouse Committee.

Dorking.—Acting upon the recommendation of the Finance Committee, the District Council has resolved to invite Messrs. Hawtayne, Trentham, and J. S. Raworth to appear before the Committee for them to select one to act as consulting electrical engineer to the Council. The surveyor recently submitted a tabulated statement showing the result of his inquiries as to electric lighting in small towns, and the above decision is the result.

Dudley and Stourbridge.—A meeting of the Dudley Town Council was held on Tuesday evening, the Mayor (Alderman G. H. Dunn) presiding. The Mayor read a special report prepared the previous day by the Railway, Tramways, and Electric Lighting Committee, who recommended that Mr. R. Wilson obtain tenders for two water-tube boilers, two engines and dynamos, and other necessary plant and machinery, and lay such report before the Committee; and that he present a preliminary report and drawings as to what he considered would be necessary for the generating station. The committee inquired of Mr. Wilson terms upon which he was prepared to accept the appointment of electrical engineer to the Corporation. He stated that his terms were 5 per cent. upon the amount of the tenders accepted for the electrical installation now proposed, and 3 per cent. on the expenditure of the electrical part of the tramways to be laid from Dudley station to the borough boundary at Hart's Hill, and from Queen's Cross to the borough boundary at Netherton, and travelling expenses, he to pay a competent clerk of the works, who should superintend all work done. The committee having considered the matter, recommended that these terms be accepted. The committee also recommended that they be an executive committee for the purpose of carrying out the necessary work of constructing and equipping the generating station, and for the supply of energy. The Committee further recommended that application be forthwith made to the Local Government Board for their sanction to the borrow-

ing by the Council of a loan of £7,500 on account of the expenses to be incurred in the construction of the generating station and work connected therewith, to be borrowed on the credit of a mortgage on the general district rate, to be repaid, together with interest thereon, within a period of 30 years. At a previous meeting of the Committee the members had passed a resolution recommending the purchase, for £1,000, of two acres of land, at Springsmire, for the erection thereon of an electrical generating station. The purchase is to include mines and minerals, but without liability to give adjacent support. The Mayor moved the adoption of the two reports, and this was seconded by Alderman Claughton, and carried after a little discussion.

Eccles.—At a meeting of the Town Council on Wednesday, the Electric Lighting Committee recommended the purchase of a strip of land adjoining the electric generating station for the purpose of extending the works, the demand by private consumers for a supply of electricity being very heavy. The Committee also recommended that the minimum charge of 13s. 4d. per quarter for a supply of the electric current be not enforced.

Epsom.—The Council, after considering data collected by the chairman regarding the success of electric lighting in small towns, has adopted the recommendation of the Lighting Committee, that tenders be advertised for for the necessary plant, &c.

Farnworth.—The report of Messrs. Lacey, Clirehugh and Sillar recommends an expenditure of £2,500 upon buildings, £7,300 upon plant, and £6,100 upon mains, &c. In connection with the proposed electric traction, says *Tenders and Contracts*, the capital expenditure necessary includes £5,800 for the extension of the present tramway, £3,777 for electrical overhead system and electric bonding of rails, £2,400 for rolling stock (four cars at £600), £2,500 for car depot, office, land, &c. In conclusion, the engineers state that an installation for lighting purposes only would in all probability not be worked at a profit until the third year, but if combined with the supply of current for electric traction would pay its way on the second year's working, whilst the tramways themselves would be a profitable investment, and the profits on the two undertakings for the third year of working should not be less than £1,180.

Gibraltar.—The Gibraltar correspondent of the *Daily Telegraph* says:—"Those of the Royal Artillery who have been stationed in the King's Bastion Barracks in previous years would hardly now know their old quarters, which have been converted into a fine up-to-date electricity supply station, with magnificent Siemens's machinery capable of creating sufficient current to light the whole garrison. The difficulty of a fresh-water supply during certain months of the year has been overcome by converting some of the barrack quarters into huge water tanks, whilst at a push salt water from the sea alongside can be condensed for use when desired. The scheme, supervised by Mr. Preece, and now in charge of Mr. Chambers, is in working order. This installation was inaugurated on November 18th, with over 3,000 lights for the military and civil Government buildings of the Rock. Since then business houses, hotels, and holders of private residences have applied for the new light. The Eastern Telegraph Company have 200 lamps in their new quarters. The Government have taken over the whole of the street electric lighting, which, in a few weeks, will supersede gas. The absence of arc lamps in the streets, Alameda, and other public spots in the garrison is much commented on. In case of attack, the supply station is well protected beneath the heavy ramparts of the King's Bastion."

Glasgow.—On 30th ult. the sub-committee of the Glasgow Corporation on the proposal to acquire the works of the Kelvinside Electricity Company had a conference with the directors, and it was decided that Mr. Chamen should go into the matter anew and draw up a fresh report for the guidance of the committee. The company offers to sell the works for about £50,000, but the Corporation estimate the value at £30,000.

Grays.—The District Council will hold a special meeting to discuss the expert's report on electric lighting.

Guildford.—The Shalford Parish Council will oppose the extension of area scheme of the Guildford Electric Lighting Company, unless the company undertakes to supply the village with current at the same rate as the town of Guildford.

Kilwinning.—A complete system of electric light is at present being fitted up at Eglinton Ironworks, and it is reported that the supply may be extended to Eglinton Ironworks village adjoining.

Leatherhead.—Messrs. Handcock & Dykes having offered to advise the Council *re* electric lighting, that body is inquiring what works they have carried out. Some councillors think that electric lighting would not pay at Leatherhead. Others suggest the trial of incandescent gas.

Leigh.—The District Council has received a letter from the Lancashire Electric Power Company, stating that the said company could not see their way to enter into a provisional agreement to bind the company as to the terms on which they would undertake to supply electricity in bulk to the Council.

Leith.—In the presence of Town Councillors and officials Provost Bennet switched on the current at the new electricity works in Junction Street on 23rd ult. The work has cost £30,000. Speeches were made by the convener of the Electric Lighting Committee, Bailie Manclark and others. The plant now in position will allow of 11,000 to 12,000 lamps being connected to the mains, but the station building capacity is for 80,000 lamps.

Moss Side.—The Council recently complained to the Manchester Corporation about the delay in supplying the district with the electric light in accordance with arrangement. The Corporation has replied expressing the regret of the Electricity Committee at the delay which, from causes beyond their control, had arisen in providing the installation. In April last the Corporation passed a resolution approving of an application to the Local Government Board for the necessary borrowing powers. The resolution was communicated to the Local Government Board two days later. The inquiry into the matter was only held in October, and the Corporation had not yet received sanction to borrow the money. As soon as sanction had been obtained the work of supplying the installation would be proceeded with. When the matter was before the Moss Side Council last week Mr. Frowde said that the electric light ought to have been supplied to Moss Side, according to promise, in October last year. The chairman said he thought the Council ought to be satisfied with the explanation given to them.

Northwich.—The Council has appointed a committee to report upon the advisability or otherwise of acquiring the lighting undertakings of the district, both gas and electric supply companies.

Norwich.—The directors of the Norwich Electricity Company have decided to supply current at a uniform rate of 5d. per unit by meter, instead of 7d., the meters being arranged to register uniformly at all hours of the day, and not, as at present, at half rate after 8 p.m.

Oldham.—Sub-Committees are considering the question of land required for the extension of the electric lighting station. The Sanitary Committee have reported that "there does not appear to be any possibility of the nuisance being abated" unless they have more water space to condense the steam.

Oswestry.—On the recommendation of the Watch Committee, the Town Council has accepted an offer of the Oswestry Electric Lighting Company to lend four 1,000-C.P. arc lamps, to be fixed in and about the Cross, and to supply current free of cost for one month. The company would undertake the whole of the street lighting at £3 per lamp per year.

Paignton.—A letter from Messrs. Handcock & Dykes offering to advise the Parish Council *re* electric lighting, led to a short discussion as to whether an installation should be in the hands of the Council or a company.

Paris.—The *Globe* says that the electric light has been installed at the Chamber of Deputies in Paris by MM. Jean and Bouchom, under the direction of a commission presided over by M. Mascart, the well-known electrician. There are 4,610 lamps in all, 1,440 in the various Parliamentary services outside the Chamber itself, 2,640 in the Hôtel de la Presidence and the Grand Saloon, and 530 in the rooms. The Chamber itself is not yet lighted, because a new and much larger one is in course of construction. Gas motors are employed to drive the dynamos, and a battery of Tudor accumulators is used to store the current. The gas motors are started by sending a temporary current through the dynamos from the accumulators.

Pembroke Dock.—It is stated that arrangements are being made to improve the electric lighting of the naval dockyard at Pembroke Dock. Hitherto the only supply has been derived from a single dynamo fitted up in No. 1 ship-fitting shop about two years ago.

Peterborough.—The electrical engineer of the Corporation has received instructions to proceed with the preparation of plans and specifications for the electric supply works.

Plymouth.—By the recent fire at the New Palace Theatre of Varieties, Plymouth, severe damage resulted to the electric light installation recently described in the ELECTRICAL REVIEW.

Portsmouth.—The Corporation electricity works were heavily taxed during the few days before Christmas. The *Hampshire Telegraph* records the complete success with which the demand was met. Everything worked smoothly and well, and although the circumstances required ceaseless vigilance on the part of the staff, there was not a single hitch or breakdown. All the plant except the steam turbine had to be used, and the large new engine and the three old ones worked very well indeed. The maximum loads were recorded on the Wednesday and Friday, the demand not being so great on the Thursday or the Saturday. On Saturday, however, the load was kept on longer, and three engines had to be run till midnight. On Wednesday and Friday the maximum load registered was 534 amperes, compared with 515 amperes registered during the week previous.

Rochdale.—The Gas Committee is now inviting tenders for the erection of the buildings required for the proposed electricity works.

Romford.—The Urban Council has postponed for a year its application for a provisional order.

Sheffield.—A cheque for just over £260,000 was handed over on Saturday by the representatives of the Corporation to the directors and secretary of the Sheffield Electric Light and Power Company, Limited, in payment for their undertaking, ownership of which was at the same time formally assumed by the Corporation.

Southport.—The Town Council have obtained from the Public Works Loan Commissioners a loan of £21,178, to be expended upon alterations and additions to the electricity plant. The principal

item of expenditure will be £8,500 for a new combined engine and alternator, for use in connection with the proposed electric tramways.

Stirling.—Last week the Police Commission accepted various tenders, £3,000 odd, for buildings and other work in connection with the erection of the Corporation electric lighting station.

The town clerk has received from the Secretary for Scotland a letter enclosing a representation from certain ratepayers against the proposal of the Commissioners to substitute steam for water as generating power for their electric lighting scheme. The representation states that they got a letter from a hydraulic engineer showing that in the lighting of the town water-power could be used very satisfactorily and at very low cost, and that this request was approved by the Board of Trade.

Stoke Newington.—Some shopkeepers on the west side of the High Street have asked the Vestry to request the Hackney Vestry when it puts down its lighting installation to lay its mains there, so that they, although in the Stoke Newington District, may have a supply of current. The Vestry has replied that it contemplates supplying the light itself, and would like to know the probable consumption by the shopkeepers in question. The Vestry will also oppose the application of the County of London and Brush Company for a provisional order. The Stoke Newington Vestry has stood in the way of the lighting being done by private enterprise for some years, and it is high time it made a move itself.

Warrington.—With reference to the Lancashire and Cheshire large power scheme, the Warrington Council has appointed a committee to attend a conference of the Municipal Corporations of Lancashire and Cheshire at the Town Hall, Manchester, on January 10th, with a view to organising an opposition to the company's Bill. Mr. A. H. Preece has submitted to the Electric Lighting Committee a report upon the electric lighting of Warrington. Mr. Preece says that owing to the difficulty in obtaining early delivery of machinery, it is necessary to take immediate steps if the scheme is to be ready next winter. In previous cases he has arranged all contracts without waiting for the Local Government Board inquiry, but a clause has been inserted in the contracts making them entirely subject to the Local Government Board sanction to the loan. This course would save at least three months' delay. In the proposed area there are included many of the principal public buildings and shops. The first plant should be large enough to supply not less than 10,000 8-C.P. or 5,000 16-C.P. lamps burning at one time, or 12,500 8-C.P. lamps fixed in consumers' premises. In nearly every town it has been necessary to consider extensions before the plant has been in working order six months. In many cases the first plant has afterwards proved small and hence uneconomical. It is not wise to have engines and dynamos of small sizes, the plant proposed will be always economical, however large the installation may become. The improved lighting of some of the streets gives everyone an interest in the undertaking. It is of advantage to all who use the streets, and it acts as a good advertisement to the industry. Hence it is suggested that arc lamps, which give a brilliant light, should be fixed in certain streets. The scheme recommended as a start will therefore consist of a plant for 12,500 lamps, including 20 arc lamps in the streets. Adequate mains will also be provided in all the compulsory streets, with plenty of spare pipes for drawing in new feeders. The site in the old gas works is in every way suitable for the undertaking. There is space for at least 5,000 H.P. Thus the ultimate plant can supply 100,000 8-C.P. lamps and 1,000 H.P. for electric tramways. The central position of the old gas works leads Mr. Preece to recommend the low pressure three-wire system. This system is of sufficient adaptability, now that 440 volts is permitted, to reach points over 1½ miles away. It also allows the use of accumulators to store electricity and supply all the energy required after midnight. The pressure is also suitable for tramways, so that the engines and dynamos can be used to generate electricity for lighting purposes, and for the tramways. The capital expenditure incurred in erecting plant and laying mains, &c., for an estimated demand of 12,500 8-C.P. lamps will be as follows:—

Boilers, including economiser, pumps, &c.		£3,900
Condenser, feed pipes, steam and exhaust pipes ...		3,000
Engines and dynamos, including two 400-H.P. sets, one 150-H.P. set, switchboards, balancer, and regulators, travelling crane		8,500
Battery and connections		1,500
Total machinery		£16,900
Mains, including pipes, excavating trenches, and making good of pavements		6,200
20 arc lamps and posts		600
House connections and meters for 150 consumers ...		900
		£24,600

In addition to the above expenditure, there is the cost of the two refuse destructors and the tipping platform, which it is necessary to incorporate with the scheme. This work will cost £3,100. The total cost of the scheme, but exclusive of the buildings, will be:—

Machinery, mains, &c.	£24,600
Destructors and platform	3,100
Engineering and contingencies	2,300
	£30,000

Mr. Preece went into the question of working costs and probable revenue, the supply of electricity for driving in factories, &c., and for tramways. He recommends the Council to take immediate steps to carry out a £30,000 scheme (buildings extra), so arranged that power may be supplied for all of the above purposes; also that two refuse destructors be erected in conjunction with the boilers for the generating plant.

Weston-super-Mare.—The District Council sitting in committee last week resolved to rescind all resolutions opposed to the transfer of the electric lighting order to a company. A subsequent resolution approved of the special committee's agreement with the Electrical Power and Distribution Company, Limited, for the transfer, and sought the Board of Trade's approval to the proposed deed. The clerk is writing to the Local Government Board withdrawing the application for a loan for electric lighting purposes. The Council's objections to the proposed application of the Weston-super-Mare and District Electric Lighting Syndicate are being drawn up.

Whitefield (Manchester).—At the monthly meeting of the Urban District Council on Tuesday, a committee was appointed to consider the question of electric lighting and traction in the district.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

All-Night Trams.—The managing director of the London United Tramways Company (Mr. J. Clifton Robinson) has initiated an all-night service of cars on its various lines. On Monday the service was successfully inaugurated on the Hammersmith and Kew, and the Acton and Uxbridge Road sections. It will be remembered that electric traction is shortly to be introduced on to some of the lines, and the all-night service will, of course, be continued if all goes well.

Bexhill.—At the meeting of the Urban District Council on Monday evening, under the presidency of Earl De la Warr, Mr. Cooper notified his intention to move at the next meeting: "That the resolution of the Council passed on November 7th, 1898, giving consent to the scheme promoted by the British Electric Traction Company, Limited, for the construction of a tramroad from Kewhurst to St. Leonards, be and is hereby rescinded."

Brixton Cable Tram.—On Sunday the L.C.C. came into possession of the tramways of South London—24 miles altogether. The daily press says that the first day's operations under the new *régime* were marked by an unfortunate accident, for in the evening something went amiss with the cable in the Brixton Road, and the whole traffic upon this branch was suspended for over two hours. The accident is attributed to one of the new grips going wrong. The trams are, of course for the present, being worked by the same staff as formerly, as the management arrangements of the L.C.C. are not yet in a settled state, but the present accident is not likely to prejudice the Council in favour of cable traction.

Cheltenham.—At Monday's Council meeting the Tramways Committee reported progress with reference to the proposed electric tramway to Winchcombe. The chairman said the proposed 4 feet 8½ inches gauge had been reduced to 3 feet 6 inches. A petition against the tramway, signed by 230 persons, had been put in, but he (Councillor Dix) thought a little trouble would obtain 23,000 signatures in favour of it. The minutes were adopted without discussion.

Dudley.—The Railway, Tramway, and Electric Lighting Committee has reported to the Town Council that Mr. Taylor (Lord Dudley's agent) is willing to sell two acres of land at Springsmire for a site for an electrical generating station, for £500 an acre, the mines to be included, but without liability to give adjacent support. The Committee, after consulting Mr. Wilson, who reported that he considered the land eligible for the purpose, has recommended that it be purchased on the terms stated. This matter is further referred to in our "Electric Lighting Notes."

Durban.—A weekly commercial contemporary says that British electrical firms should not lose sight of the fact that the Durban Town Council have appointed a commission of two engineers to investigate and report upon the electric street railway systems of America and Europe, in order that they may intelligently decide upon the best system to be installed in Durban.

Edinburgh.—The Tramways Committee last week agreed to recommend that no action be taken on a motion by Councillor Alexander Gray to work the Portobello section by means of a conduit electric system; but consideration as to whether the cable should be worked by a power station at M'Donald Road or by an electric motor was deferred.

Fenton.—The Urban Council will not object to the British Electric Traction Company's application to the Board of Trade for an extension of time for the completion of the Potteries Extension Tramways until August 7th next.

France.—A company has just been formed in Paris with a capital of £120,000, to be known as La Compagnie des Tramways Electriques d'Elbeuf.

Glasgow.—Last week the Tramway Committee approved of the minute of its sub-committee that the present Glasgow tramway system should be converted into an electric system as soon as possible by extensions of the trolley lines. The entire conversion is planned to be completed by 1901. It was agreed, however, that a watch should be kept meantime for any improvements in the conduit system which might render it suitable for adoption in Glasgow under present conditions.

Italy.—The Helios Company, of Ehrenfeld, Cologne, Germany, has just secured a 40 years' concession to establish and work a large central electric power station for the generation and supply of electrical energy for power purposes, and to construct and work a system of electric tramways in Spezzia, Pertusola, and San Bartolomeo.

Kingston-on-Thames.—The Drake & Gorham Electric Power and Traction (Pioneer) Syndicate have just laid before the General Purposes Committee of the Kingston Corporation a proposal to establish an electric tramway along certain roads in the borough. The capital proposed to be raised is £100,000. It is proposed that the lines shall be worked on the electric overhead trolley system, the current to be supplied from the Corporation's electric lighting works, the Corporation also to supply the plant required. The syndicate agree to promote the order, and to insert clauses enabling the Corporation to acquire the undertaking under fair conditions, at a period of not less than 14 years.

Leeds.—The Corporation have decided to start forthwith upon an extension of the electric tram system to Headingley and Chapeltown, and according to present ideas the new cars will be running by the end of May. The new route will be about six miles in length, and will serve the principal residential districts of the city.

Lincoln.—The Tramways Company recently passed the following resolution:—"That the directors having under consideration the desirability of introducing (as in other towns) electricity as the motive power in working their tramway system, and the necessity of meeting the reasonable demands of the public for an extension of the system, as also the possibility of the tramways being taken over by the local authority, are of opinion that under these circumstances the company would not be justified in incurring the heavy capital expenditure which these improvements and extensions would involve without first conferring with a representative committee of the Council on the subject, and the directors accordingly ask the Council to appoint such a committee at an early date." The Council has since appointed a small committee to confer as desired.

Manchester.—The question of the conduit as against the trolley system is to be reopened, and a suggestion has been made that the Manchester Corporation should send a small deputation to New York to investigate. The correspondence in the local papers still continues with more or less vehemence.

Mexico.—The *Mexican Herald* for December 14th contained the following interesting item of information:—"Eng. Mateo Plowes, of the City Council, is of the opinion that the poles that are now being erected in connection with the overhead system of electric traction for the street cars may, by virtue of the effects of electrolysis corrode the water mains. It appears that he has won over other aldermen to his way of thinking. It is probable, in consequence, that work on the extension of the system of electric traction will be suspended until the question has been thoroughly investigated."

Southport.—Application is intended shortly to be made to the Board of Trade by the British Electric Traction Company for a provisional order authorising the construction of certain electric tramways in Southport and Birkdale. The Southport Corporation also have on hand an electric tramway scheme which will pass along the route proposed to be traversed by the company. The Town Council are consequently taking the necessary steps to oppose the provisional order. The Board of Trade inquiry is expected to take place in March or April.

Sydney.—The general adoption of the overhead electric system in connection with the tramways of the city and suburbs will probably be undertaken at an early date. Within four years, says the *British Australasian*, the present mixed system will be a thing of the past. Authority for the adoption of electric traction in place of steam was given some time ago, on the understanding that the change would not be started till the George Street electric tram was running. This, it is anticipated, will be completed within a few days.

Wednesbury.—On Monday, at a meeting of the Town Council, Mr. T. Jones, the town clerk, intimated that he had received a draft of the Bill proposed to be introduced into Parliament by the British Electric Traction Company to enable the company to take over the powers of the South Staffordshire Tramways Company. Mr. Jones stated that in addition to providing for the purchase of the undertaking of the present company, it arranged for a lease of the tramways and gave the local authorities power to purchase at the end of 35 years. On the motion of the Mayor, it was decided that this question, as well as a communication relative to the Wolverhampton Tramways Bill, be referred to the General Purposes Committee for consideration.

Wolverhampton.—At a meeting of the Wednesfield District Council last week the clerk (Mr. J. W. Stirk) reported having interviewed the town clerk of Wolverhampton and several members of the Town Council in regard to the omission of Wednesfield from the tramway scheme. It was explained that the omission was quite accidental, and would be remedied by a provisional order for the extension of the lines from Heathtown to Wednesfield.

Wrexham.—Mr. Albright, on behalf of the promoters, explained the proposed electric tramway scheme to a meeting of ratepayers on 23rd ult.

TELEGRAPH AND TELEPHONE NOTES.

The National Telephone Company's Bill.—By the Bill which has been deposited by the National Telephone Company for introduction into Parliament next Session, and comprises 106 clauses, it is proposed to dissolve the limited company and reincorporate it with Parliamentary powers to carry out the objects of the company, as set out in the Bill, throughout "the British Islands." The share capital of the new Parliamentary company is to be £6,000,000, with power to raise a further £3,000,000 by the creation of debenture stock. Of this capital £4,000,000 is represented by the existing share capital, and £1,669,471 has already been raised by debenture stock out of an issue of £2,000,000. Part 7 of this Bill proposes to give to the company adequate facilities for placing and maintaining their wires within the districts of those public authorities in which they have been unable hitherto to obtain proper facilities. A schedule attached to the Bill contains a list of the public authorities in whose districts adequate facilities have been given, and it is expressly enacted that part 7 of the Bill shall not apply within their districts. It may be mentioned that the clauses contained in this part of the Bill are also made the subject of a second Bill, which has been deposited by the company, in order that they may be separately considered should Parliament think fit to do so. The preamble of this Bill states that telephone messages at the rate of 450,000,000 are now passing annually over their system.

New Mediterranean Cable.—We learn from a Gibraltar correspondent that the Telegraph Construction and Maintenance Company's cable steamer *Anglia* arrived there on Monday last from London, and next day laid the shore-end of the Eastern Telegraph Company's new cable connecting Gibraltar with Alexandria *vid* Malta; leaving at midday paying out the cable. This will make the third cable between Gibraltar, Malta and Alexandria.

The Pacific Cable.—A Reuter's despatch from Washington says that Mr. Hay, Secretary of State, has formally expressed his disapproval of the concession made in July last by Hawaii to the Pacific Cable Company for the exclusive right of laying a cable between the United States and Hawaii, and thence Japan and the intervening islands. This action, Mr. Hay explains, is not taken in a spirit of hostility to the company, but on account of a formal protest of the Hawaiian Commission, and because it seems best to leave to Congress a free hand in the disposition of the whole subject.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
Para-Maranham	Nov. 14th, 1898 ...	...
LANDLINES.		
Majunga-Tananarive ...	Jan. 3rd, 1899 ...	...
Saigon-Bangkok	Dec. 30th, 1898 ...	Jan. 2nd, 1899.
Communication with Fao (Between Divanich and Semava)	Dec. 24th, 1898 ...	...

Trans-Atlantic Cables.—After alluding to the steadily-growing dividend which is paid by the Anglo-American Telegraph Company, the *Financial News* goes on to state that: "The proposed Pacific cable from Australia to Canada, of which we have heard a good deal lately, will, if it is to fulfil its *raison d'être* of affording us an 'all-British' cable road from the East, have to work in connection with the Anglo, as that is the only Atlantic cable which lands on British territory, and the improved relations which now exist between Great Britain and the United States tend rather to increase than diminish the business between those countries." By some strange oversight no mention is made of the other six cables, all of which land on British territory on each side of the Atlantic, so that there are no less than 10 trans-Atlantic cables which may be looked on as "all-British" as far as landing places are concerned.

York Telephones.—The City Council has consented to the application of the National Telephone Company, who want to lay the twin-wire system underground in substitution for the single wire system. The company is required to pay 5s. per annum for each subscriber with a minimum of £50, 10s. for each large junction box, and 5s. for each small ditto.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barrow-in-Furness.—January 20th. The Corporation is inviting tenders for the wiring of the free library, Cornwallis Street. Plan of building at the office of the Borough Electrical

Engineer, Town Hall, and specification from the Town Clerk, Town Hall, on payment of £1 1s., returnable as usual.

Burnley.—January 10th. The Corporation wants tenders for underground electric light cables and switchboard. See our "Official Notices" December 16th.

Christiania.—February 26th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Telegraph Administration for the delivery of about 140,400 porcelain telegraph and telephone insulators. Tenders must be received at Christiania by 12 o'clock noon on February 26th, 1899. A copy of the specification, conditions, &c., may be examined on personal application at the Commercial Department of the Foreign Office any day, between the hours of 11 a.m. and 5 p.m.

Edinburgh.—January 9th. The Council invites tenders for switchboard and boosters for the Macdonald Road lighting station. See our "Official Notices" December 16th, 1898.

Glasgow.—January 21st. The Corporation invites tenders for generating plant at one or other of their new electricity works:—Two engines each of 200, and two of 400; three of 1,100, and two of 2,200 indicated horse-power, with dynamos and condensing plant. Specifications, forms of tenders, &c., from Mr. Chamen, city electrical engineer. See our "Official Notices" December 16th, 1898.

Govan.—January 23rd. The Commissioners want tenders for the supply of water-tube boilers, feed heater, engines, dynamos, equalising transformers, boosters and motor pump, cables, accumulators, arc lamps and standards. Specifications from Mr. W. Arnot, 57, West Regent Street, Glasgow. See our "Official Notices" this week.

London.—January 31st. The L.C.C. is inviting tenders for four continuous current dynamos, one motor generator, two switchboards and switches, &c., for the proposed Victoria Embankment installation. See "Official Notices" December 30th, 1898.

Lowestoft.—February 6th. The Corporation want tenders for the supply of boilers, steam dynamos and motor boosters, storage batteries, switchboard, travelling crane, mains, arc lamps and posts; and for the lighting of the station. Consulting engineer, Mr. W. C. C. Hawtayne. See our "Official Notices" this week.

Roumania.—January 16th. Tenders are being invited until January 16th by the General Direction of the Roumanian Post and Telegraph authorities in Bucharest for the supply of 2,000 small porcelain insulators, 15,000 medium size ditto, and 10,000 large ditto.

Southampton.—January 16th. The Corporation wants tenders for transformers and fittings. See our "Official Notices" this week.

Tunbridge Wells.—January 11th. The Corporation is inviting tenders for the erection of three telephonic fire alarms within the borough. Tenders to the Town Clerk.

CLOSED.

Bristol.—The Museum Committee of the Bristol Corporation has accepted the tender of Messrs. Mendham & Co., for a large extension of the electric light into various rooms in the Curator's Department in the Bristol Museum. This firm have just completed the fitting of the electric light into the pump room of the Clifton Grand Spa, use being made of the existing elaborate gas chandeliers; and also the fitting of electric bells for Lord Fitzharding at his mansion at Hounslow.

Leeds.—The Tramways Committee, some days ago, let the final contracts for works in connection with the equipment of the Headingley, Chapeltown and Hunslet tramways with electric traction. The committee accepted the tender of Messrs. W. T. Henley's Telegraph Works Company, for underground pipes and conductors, at £8,966, and the tender of Messrs. Greenwood & Batley, for switchboards and auxiliaries, at £5,330. The equipment of the Headingley-Chapeltown line will be proceeded with at once.

FORTHCOMING EVENTS.

Tuesday, January 10th.—At 8 p.m. The Institution of Civil Engineers. Paper on "High-speed Engines." By John Handsley Dales, A.M.I.C.E.

At 8 p.m.—Röntgen Society, 11, Chandos Street, Cavendish Square, W. Paper by J. Battersby, M.B., Major, Royal Army Medical Corps, on "The Present Position of the Röntgen Rays in Military Surgery."

Friday, January 13th.—At 8 p.m. The Institution of Civil Engineers. Students' Meeting. Dr. Archibald Barr, M.I.C.E. (Professor of Civil Engineering and Mechanics in the University of Glasgow), will deliver an address on "The Application of the Science of Mechanics to Engineering Practice."

NOTES.

Electrical Work in the Philippines.—We have already referred in these columns to the bright prospects for electrical development in the new American possessions. To what extent British electrical manufacturers will benefit by the change of ownership it is not easy to prognosticate with any degree of certainty. If the open door policy is carried into effect, we shall be competing with Americans who are already giving close attention to the likely requirements of their newly acquired colonies. Brother Jonathan may appear to be placed in a better position by virtue of ownership, but we must bear in mind that in some places a large portion of the trade is controlled by British merchants, and if British manufacturers at home are in a position to meet their electrical requirements, we are justified in looking for some good business for English works. Undoubtedly electricity will be a very potent factor in the development of the Philippines and Cuba, but, if we are going to maintain our shopkeeping reputation, we must wrestle with the thing at once. We read that there is already a Spanish-made electrical plant installed at Manila, and a telephone exchange service is in operation. *Sell's Commercial Intelligence* advises that, in view of developments taking place shortly, electrical engineers should keep themselves thoroughly posted as to the course of events. We cannot do better than endorse this advice.

An American Technical Institute.—The year 1898 was a very good one, financially, for the Massachusetts Institute of Technology. The late Hon. H. L. Pierce left the handsome bequest of $750,000, and by the will of a Mrs. James, the Institute benefited to the extent of $140,500. Other donors have given respectively $20,000, $10,000, and $1,482. For a travelling fellowship in the architectural department, the sum of $6,000 has been given, and under another will $40,000 is given for scholarship purposes. According to the annual report of President Craft, this great increase of funds came when it was much needed, and it led to improvements in the old premises, and the erection of a new fireproof building. The total number of students for 1898 was 1,171, as against 1,198 in the previous year. The average actual expense of instruction per student works out at $330 per year, while only $200 is paid as tuition fees. Without counting lecturers, there is one instructor to every eight or nine students—a very high average.

The Explosion of Electric Detonator Fuses.—A report to the Home Secretary by Major A. Cooper-Key, R.A., Inspector of Explosives, on the circumstances attending an explosion of electric detonator fuses at the factory of the Cotton Powder Company, Limited, at Upless Marshes, Faversham, Kent, on September 2nd, 1898, has been issued as a Blue-book. Two women died from the effects of the explosion, and two other women were severely injured. When the accident occurred, says the *Times*, the women were employed in testing and tying up into bundles low tension electric detonator fuses, and one of the women, since dead, stated that the accident had been caused by crossing the wires during the operation of testing. After examining the probable causes of the explosion, Major Cooper-Key arrives at the opinion that the accident was caused by one of the workpeople treading on a detonator, the resulting explosion being conveyed by other detonators to the main supply, and thence to all explosives on the same side of the building. Among the *débris*, after the explosion, there was discovered an overboot of substantial make, with a mark on the sole which had evidently been made by the explosion of a detonator.

Appointments Vacant.—The Hanley Corporation wants two assistant electrical engineers at £80 per annum. The Bristol Corporation invites applications for the post of station superintendent at £175 per annum; and the Shrewsbury Lighting Committee want an electrical engineer and manager at £250 per annum. For particulars of these vacancies see our "Official Notices" this week.

The Société Internationale des Electriciens.—At a recent meeting of the Société Internationale des Electriciens, M. R. V. Picou presiding at the commencement of the proceedings, and M. Pollard afterwards, the President referred to the deaths that had occurred, and read the list of new members. M. G. Pelissier was the first to speak, and he chose for his subject the prices charged for electrical energy. He dealt upon the importance of lowering the tariffs whenever the working justified a reduction of prices. A diminution of prices always corresponded to an increase of profits. It was important to find in all cases the lowest limit. The selling prices should always be rational and convenient. M. G. Pelissier quoted several examples, and arrived at the system of tarification proposed by Mr. Wright and used at Brighton. M. de Marchena then gave a description of the tramways on the combined trolley and accumulator systems from Aubervilliers and Pantin to the Place de la République, Paris. The track in Paris is about 6·2 and 6·75 kilometres in length. Broca and Vignoles rails are used. In Paris the tramways are worked by accumulators, and outside by the overhead trolley system. There are 56 seats, 24 inside, four on the platform, and 28 outside. The accumulators are supplied by the Société pour le Travail Electrique des Métaux; they comprise 224 elements, of seven plates per car, and their capacity is 35 ampere-hours. Their weight is 4 tonnes, the total weight of the car amounting to 17·8 tonnes. The cars are provided with electro-magnetic brakes, enabling a car to be stopped in less than 20 metres on an incline of 21 millimetres per metre. The station supplying the electrical energy is situated at Aubervilliers, and contains three Roser boilers with a heating surface of 260 square metres, three horizontal Corliss engines of 250 H.P. at 75 revolutions a minute, and three compound Thomson-Houston dynamos of 150 kilowatts at 550 volts and 400 revolutions a minute. The difference of potential can be brought to 575 volts for the charging of the accumulators. This tramway line has been working for several months and has given complete satisfaction. At the end of the sitting, M. Maurice Leblanc presented a very interesting paper on alternators with a constant difference of potential.

Water-Power in Canada.—If the United Kingdom be deficient in the natural supply of large and easily developed water-powers, the same cannot be said of one of her most promising colonies—Canada. Already many power stations have been put in operation, while others are approaching completion. The more important of these are the following:—1. Lachine Rapids Power Station, opened September, 1897, cost $2,000,000, power = 25,000 H.P. to be transmitted to Montreal; 2. Richelieu River Power Station, power = 20,000 H.P. to be transmitted chiefly to Montreal; 3. Buckingham Power Station, power = 6,000 H.P.; 4. St. Lawrence Power Station at Massena, power = 75,000 H.P. (not completed.) To the above must now be added a power-development scheme on the St. Maurice River, where 100,000 H.P. is said to be available for industrial purposes. According to *Electricity* (New York), three power companies, the Shawinigan Power Company, the Laurentide Pulp Company, and the Canada Iron Furnace Company, are already at work in the thickly wooded valley of the St. Maurice. The first of these intends to transmit power to Montreal and Quebec. The former city, when this company has carried out its plans, will be served by three *independent* power companies, and so long as they remain independent, electrical energy will be cheap in Montreal. If the city authorities are wise, they will insert a clause in the concessions to these companies, forbidding any amalgamation of interests. The St. Maurice River power scheme is said to be a most promising one, as little expenditure upon hydraulic engineering works will be necessary, in order to render the power available for utilisation. The number and the magnitude of the power schemes now undergoing developments in Canada, would seem to indicate that at no distant date the valley of the St. Lawrence River may be one of the busiest manufacturing districts within the confines of the Empire; and portion of the surplus capital and business energy, which are supposed to be waiting for the opening of China, in order to find an outlet, might, with benefit to all concerned, be directed towards the development of the most progressive of our Colonies.

Utilising the Tides.—The idea of utilising the enormous aggregate power of tidal ebb and flow for the service of man is by no means a new one, and in all ages of the world the problem has attracted the attention of ambitious inventors. But although many have attempted to solve it, none have succeeded; and the tides continue to ebb and flow round our coasts and in our river estuaries to no practical purpose beyond that of preserving our shores and estuaries from unhealthy accumulations of deposited matter. We hear, however, that Thomas Edison, jun., doubtless considering the problem suited by its magnitude to the inherited genius of his family, has attacked it, and has induced New York capitalists to provide him with £210,000 for carrying out a practical trial of his scheme in the East River, New York. The chief advantage of a great name in the world of invention is the ease with which it commands capital for trial of the ideas of its bearer, for we have no hesitation in saying that had some unknown inventor brought forward Mr. Thomas Edison's scheme, he would have found great difficulty in raising one-hundredth of this amount for its trial. We cannot say that we quite understand the description of Mr. T. Edison's scheme as given in *Electricity* (New York), so we give the extract in full:—

> The plant, if built, will consist of two metal pipes, 15 feet in diameter, and 100 feet in length, located under water in the channel, and mounted on a solid masonry foundation. These pipes are to be pivoted in the middle, and made to act as walking beams through an automatic device actuated by the water flowing through them. The ends of these pipe walking beams, as they might be termed, will then be made to operate the piston rods of compressed air cylinders. The compressed air obtained in this way it is proposed to utilise for running triple expansion engines, which will in turn operate dynamos. The plant will be reversible, that is, capable of operating whether the tide is running either in or out, and at high and low tides, during the time the water is practically stationary; compressed air will be drawn from a set of storage cylinders to keep the electrical machinery in continuous operation.

We shall await with interest further information concerning the progress of this scheme. If Mr. T. Edison, jun., solves the problem of the profitable utilisation of tidal energy, he will certainly add lustre to the family name, and be regarded by future generations as one of the greatest benefactors of the human race. But —— we are not very hopeful.

The Ratio of Dynamo to Turbine Rating.—The steam engine is well known to be a machine capable of working considerably above or below its most economical loading without any serious falling off of its efficiency. Not so, however, the ordinary turbine, which must work at or near its maximum power. A turbine on a fall of water which is not much in excess of demand must thus be proportioned to its load, and cannot be run at more than 10 per cent. overload without a too serious loss of effect at normal loading. The *Electrical World* compares the electrical motor to the steam engine in this respect. The motor can be very considerably overloaded for a time. The limit of overload is fixed by the heating. Gas engines are like turbines. They become less economical at light loads, and must at present be fairly well loaded to their maximum in order to be economical. It is because of these facts that multiple nozzle Pelton wheels or Girard turbines should be considered in any scheme of water-power where the supply is not superabundant. But on superabundant falls of water, there is no objection whatever to working ordinary guide-blade turbines at part gate so as to provide a wide margin of power for increase of load. As the gate is opened the wheel does more work, and does it for proportionally less water. In gas power stations reasonable division of units must be made, and as the power curve rises a fresh unit must be prepared and thrown into action. For gas power there is still much to be said in favour of the arrangement of the generators driven off a common shaft, itself driven by the various engines and divided into convenient lengths, coupled by some form of claw or friction coupling.

Electrical Effects in a Storm.—We read that the steamer bringing from Hamburg the electric apparatus and other properties needed for Miss Loie Fuller's performances at the Lyric Theatre was detained by the stormy weather, and Miss Fuller's appearance had in consequence to be postponed.

The Southampton Fatality.—The Board of Trade inquiry into the electric shock fatality at Southampton, to which we have already made several references, was held on 20th ult. by Major Cardew :—

The town clerk opened the case and narrated the facts.

Henry Flux, a labourer, repeated the evidence given by him to the coroner.

Mr. J. Brooking, electrical engineer, and manager for Messrs. Glover & Co. in Southampton, in the course of his evidence stated that they had been working day and night to get the mains ready. Since the accident the joints had been taped over. He had traced back the cable to what he imagined to be the low tension pipe. The two pipes, high and low tension, are nearly alike, and there is no external mark to tell which is the high tension pipe. Had he known the leakage was in the high tension cable, he would not have allowed Day to repair it without first having the current switched off. He did not remember having made temporary joints on high tension cable before. He mentioned to Mr. Shepherd (the clerk of the works) that he did not like putting in a temporary joint, but on being pressed he thought it better to do so. He was aware of the Board of Trade regulations, but did not think that they were strictly adhered to in this case.

By the town clerk: It was possible to make a temporary joint as safe as a permanent one, but only by using extra thicknesses. He had the joints made, as he thought, very safe, and had extra material, although not so much as he thought.

John Shepherd, electrical engineer, clerk of the works for the laying of the mains, said that when he was told of the leakage he was apprehensive of danger. He had seen the joints made, and was satisfied with them. He had heard that it was necessary that the work should be put on.

Frederick H. Chaplin, resident electrical engineer at the Corporation works, believed that an undertaking had been given to supply current to several consumers, amongst them being the new theatre, the new Avenue Congregational Church, and large business premises, on the 7th inst. Owing to the need temporary joints were made in that particular box and two others. There was a current of above 2,000 volts going through the high tension cable on the day of the accident. He held the opinion that the reason of the joint being forced against the brickwork was owing to the vibration from the railway tunnel underneath. The current was complete as far as it went, and he tested the high tension cable with a current of 2,300 volts. He thought that when the box was complete the joints would be secure.

Mr. E. Manville, consulting engineer to the Corporation, was next called.

Before he gave evidence, the Inspector said he wanted to know who was responsible for the delay through which the temporary joints had to be constructed?

Mr. Manville replied that in that connection the work was very much behindhand, and the Corporation, through him and the town clerk, had pressed the contractors to complete the work, and no doubt it was due to the non-completion of the work that the temporary joints were made. Although they were temporary joints, they ought to have been fit for the work they were to do. They ought to have been fit to run, if necessary, continuously. He maintained that if they had had proper metallic shielding an accident of that sort could not have resulted.

Answering Mr. Bassett, the town clerk said that the contract was made on December 3rd, 1896, and the work should have been completed six months after the written order was given.

The Inspector subsequently visited the scene of the fatality.

Electro-deposition of Gold in the United States.—Up to the present the Transvaal is the only district in the world where gold is recovered from the tailings, or slime solutions, by aid of the electric current. The Siemens and Halske process will be soon worked in the United States, where larger installations are to be erected. The anodes will no longer be made of iron, but will consist of peroxidised lead, in order to avoid the troublesome formation of prussian blue. The following is an extract of the last number of the *Engineering and Mining Journal* :—"We are informed that Mr. Charles Butters has secured a lease on one or more of the tailings dumps of mines on the Comstock lode, and that he is now engaged with his assistants from his metallurgical laboratory in Salt Lake City in making an examination of the ground. His object is doubtless to treat the tailings by the Siemens-Halske process, which he is introducing into this country, but no particulars have yet been made public as to his plans. This will be the first working of this process on a large scale in the United States and will be watched with much interest."

Society of Arts.—In the list of arrangements for the ordinary meetings for January and February, we notice the following :—February 1st, "The Cost of Municipal Enterprise," by Mr. Dixon H. Davies; February 22nd, "Electric Traction and its Application to Railway Work," by Mr. Philip Dawson.

An Improvement in Telephone Exchanges: the Suppression of the Telephone Bell(e).—Few whose lot it is in their daily life to make much use of the telephone have not experienced the aggravating "cut off" in the middle of a business conversation, or the almost equally aggravating interruption of the telephone girl, with her agonised "*Ar'nt* you finished?" According to *Electricity* (New York) the telephone company of that city is experimenting with a comparatively simple device that avoids both these evils. When a subscriber of the company removes the receiver from its hook or rest, a tiny glow lamp lights up beside his number at the district centre; when the desired connection is made, a second lamp lights up. While these two lamps continue to glow the telephone girl knows that the two subscribers are using the line; when one or both of the lamps ceases to give light, she knows without inquiry that the line is free. The lamps thus replace the bells at the district office, and if the system works properly the saving to the vocal organs of the telephone girls and to the tempers of the company's clients must be enormous. Our New York contemporary rather unkindly remarks that this deprival of an excuse for talking, even though the words uttered be merely "Ar'nt you finished," will not be regarded with joy by the telephone girl. Possibly she takes a feminine pleasure in seeing how many shades of expression, ranging from mild inquiry up to righteous indignation, she can get into this well-known telephone formula. But supposing the filament of the incandescent lamp breaks unknown to the telephone girl! What does she do then when the tiny glow lamp jibs?

The Advantages of Competition in Electric Supply.—New York is at present reaping the benefit of possessing two independent electric supply companies, which cover to a certain degree the same area of the city, and the consumers of electricity in New York are rejoicing at a tariff war which has sprung up between the two supply companies. This happy condition of things is, of course, denied to Londoners—at present. In a recent issue (see ELECTRICAL REVIEW, November 11th) we gave some details of the reduction in charges made by the Edison Electric Illuminating Company. The rival company, the United Electric Light and Power Company, has now followed in the steps of the Edison Company, but bent upon doing the thing handsomely while about it, this company has reduced its charges 25 per per cent. below those of its competitor, the managers of which are probably now regretting their first step in "rate-cutting." There is talk of a further reduction by the Edison Company as an answer to the bold challenge of their rival, and it will be interesting to see how the war ends. Both companies have stated that owing to improvements in engines and machinery current can now be generated much more cheaply than formerly. We have not heard of any well-established English supply company basing a reduction of its charges upon this ground. Doubtless it is one of those discoveries that are only made under the pressure of outside competition. We commend the admission of this fact by the New York companies, however, to the attention of English consumers of electric energy, either for lighting or power purposes, as a useful argument in favour of the policy of free competition.

Night Signalling at Sea.—Our New York contemporary, *Electricity*, in a recent issue gives some details of a rather novel method of signalling at night by aid of the electric light, with which experiments have been made upon the U.S. battleship *San Francisco*. The experimental trials were made last August, when the *San Francisco* was off Cape Cod. An arc light lantern provided with a 1,000-C.P. arc light, a white sail cloth stretched to form a 12-foot screen, and lantern slides of all the letters of the alphabet, were the necessary items of apparatus. The lantern and screen were so arranged on the deck that the letters thrown on the screen would be visible to the sister ship, and the message to be communicated was then spelled out, letter by letter, upon the screen. The 10-foot letters were said to be clearly visible at a distance of two miles. As all modern passenger and naval ships are equipped with the electric light, this method of night signalling may prove useful under certain circumstances, and its adoption may become general on such vessels.

Reported Copper Combine.—The New York correspondent of the *Financial News*, in a despatch dated 4th inst., says that the reports of a copper combine are undoubtedly largely exaggerations, though there is some truth at the bottom of them. He proceeds:—

The Anaconda and the Calumet, however, are not considering any proposals; in fact, they have received none from the Standard Oil interests, who are credited with backing the combination. The active demand for copper, resulting from the enormous expansion of electrical business, has proved an attraction to the Standard Oil people, and they are endeavouring to secure a general consolidation, beginning with the Montana properties and then the Michigan properties. The Bay State Gas Company, which is controlled by them, and has $50,000,000 of capital, has the Delaware State Charter giving it the right to increase its capital without limit. The price of this stock has recently advanced to nine from four, on reports that the capital will be increased to $100,000,000 and that the company will constitute the central company to purchase all the large copper companies by the exchange securities. This report has, however, been exploded, and a sharp break in copper stocks has followed during the last few days, though some believe the current break in prices is due to Standard Oil manipulation, with a view to buy in at low prices. There seems little doubt but that the Butte and Boston will be consolidated with the Boston and Montana, as the Standard Oil controls them, and these are adjacent to the Anaconda; so it is expected that overtures to the Anaconda will soon be made. It is certain, however, that no attempt has recently been made to buy large blocks of Anaconda or Calumet in the open market. A reliable copper authority said to-day that even if the combination reaches no further than the Montana, it will take some time to arrange the details, and nothing definite will be known for weeks. There are undoubtedly some advantages in consolidation, such as reducing expenses, arranging railroad rates, and fighting the battle that must one day be fought with the Miners' Union for a reduction of wages from $3·50 per day.

Personal.—After the completion of over 40 years of service in the Telegraph Department, Mr. John Henry Cordeaux's retirement took effect on October 20th. During the greater part of last year he occupied the position of Acting Principal Technical Officer in the Engineer-in-Chief's Department of the General Post Office, and his colleagues in that Department have just signalised their personal regard and their appreciation of his social and official good qualities by the presentation of a handsome silver tea service, the tray of which bore a suitable inscription. Unfortunately Mr. Cordeaux's state of health would not permit of the presentation being made at the Post Office, so Mr. Hookey, Assistant Engineer-in-Chief, kindly undertook the pleasing duty at Mr. Cordeaux's house in the presence of a representative deputation. Nearly 100 officials contributed to the testimonial.

Dangers due to Electric Motors.—Attention is called in the *Electrical World* to the dangers of electric motors, especially when geared down by worm gearing in respect of the heavy strains they may impose if they continue to run when they should not be running. The recent electric elevator accident was due to this, and other cases have happened where electric motors have torn the ropes off the drums, broken wheel spiders, and stripped teeth. The trouble is largely due to the very great maximum torque of the motor, as compared with its normal power, especially when shunt wound, and it is urged that some automatic weakest link should be provided as a breaking piece. Fuses are too slow to provide safety of the kind required, so that circuit breakers should be installed. Their disadvantage is the readiness with which they can be overweighted, or even tied in, and a good circuit break free from the danger of being tampered with, would be a welcome blessing. A good one could be exactly calculated for. Where there is much kinetic energy, however, provision is also required for this, and may be got by suitable safeguards or slip connections.

Paris Praises American Automotors.—If we are to believe a report printed in a London evening paper, Count Déjotemps, of Paris, has given an order for the supply of 1,500 automotors annually for the next 10 years. For the advance order of 15,000 vehicles, the total sum is given as $15,000,000, or $1,000 (about £200) apiece. The orders have been distributed among all the makers in a manner which is designed to give control over America's exportable surplus. In giving the order, the Count says he conceived the idea upon the conviction that the world supplies no horseless vehicles comparable to those of the United States in speed, strength, and ease of running, whether by electricity, gas, steam, or oil. The deliveries of the automotors will begin in March.

A Meter Muddle.—A consumer on the mains of the Norwich Electricity Company writes to the local press in a perplexed strain, hurling all sorts of diatribes at his electric meter. He complains that it registers a far greater amount of current than he is using. The company's engineer suggests that the wiring is at fault. "The best electrical engineers in the city" made tests which proved there was nothing wrong with the work. The electricity company made tests of the meter and said it was correct. The company sent another man, who said that the meter was wrong, and must be replaced. The first tester called a second time, and said the meter was all right, and he did not call the second tester an angel. The second tester has not yet called again. Well may the perplexed consumer wonder what to do next.

Sound-Board Telephone.—As we go to press the following communication comes to hand from Dr. Oliver J. Lodge:—"In the talking and singing experiment which I showed to the Institution of Electrical Engineers on December 8th, I did not make it clear whether or not I was using any of the magnifying telephones that were on the table in addition to the sound-board telephone. In answer to inquiries, will you allow me to say that I was not. There was no magnification in the case. The speech currents were taken direct round the little coil attached to the deal board and suspended in a magnetic field. And only one such coil was in that instance used. The articulation of a sound-board telephone can be decidedly good as well as loud, and there need be no nasal twang such as is caused by a resonant trumpet or cone."

London County Council Tramways Appointment.—A *Times* correspondent says that the Tramways Committee of the Nottingham Corporation have so modified their position that Mr. Baker will be released at the end of this month and will be free to take up his duties as manager of the London County Council tramways. The Nottingham committee at first declined to let Mr. Baker go under six months' notice, but, being anxious to meet the wishes of the London County Council and of Mr. Baker, they, on Tuesday, appointed Mr. John Aldworth, of the Isle of Man electric tramways, to succeed Mr. Baker at Nottingham. Mr. Aldworth was one of the three from whom the London County Council made their selection.

Raising Debentures on Copper Conductors.—Some weeks ago we referred to Prof. Forbes's suggestion that for his Egyptian power transmission scheme a mortgage might be raised by means of debentures on the long lengths of copper conductors employed. We remarked that this had been previously suggested by Mr. B. H. Thwaite in 1892, in a paper read before a provincial Institution. We find, however, that in January, 1892, nine months before Mr. Thwaite's paper was read, Prof. Forbes put forward the proposition in a previous series of Society of Arts lectures, so that there is no doubt as to who was first.

Presentations.—On the occasion of his leaving Aberdeen to fill a situation on the staff of the new electricity works at Leith, Mr. James Spark was recently presented with a handsome Gladstone bag as a parting gift from his fellow workmen.

At Glasgow last Friday, Mr. James Crombie, of the Eastern Telegraph Company, Limited, was entertained by the staff, and by a large circle of friends, to a cake and wine banquet, to celebrate the 25th anniversary of his service with the company. He was also made the recipient of a silver fruit and fish service. Mr. Renwick, superintendent of the Glasgow office, presided.

Lectures.—Prof. A. Jamieson, on 27th ult., lectured before the Aberdeen Mechanical Society on "Electric Railways and Tramways."

On 27th ult. Prof. W. F. Barrett delivered a second lecture on "The Wonders of Electricity" at the Royal Dublin Society.

Portraiture.—The January number of the *Machinery Market* contains a good portrait of Sir David Salomons, Bart., together with some notes on his career.

The Calorific Power of Weathered Coals.—Some recent tests of American coals, weathered and unweathered, have shown that the weathered samples contained less carbon, hydrogen and nitrogen, and more oxygen than the unweathered coals. This amounts to saying that weathering favours slow oxidation, and a weathered coal is already partly consumed before use. Actually, the results show very small differences, and the coals do not give laboratory results at all consistent with experience. It is at least a fact that weathered coals are deemed much inferior to fresh coal. A decrease of one-half of 1 per cent. in calorific value is not a very serious diminution, and if the tests of Messrs. Hale and Williams are fair indications from long-exposed samples of what happens to coals exposed, say, on a quay at Port Said, then some other factor must be sought to explain the alleged poverty of weathered coal. We can understand that coals at a foreign station, such as Port Said, might prove troublesome in the furnace by reason of the large amount of sand which they may contain, this being wind-borne and conducing to very excessive clinkering, and probably it often occurs that coals have heated on the voyage from England and have lost much of their nature in the process, for a weathered coal is often little better in appearance than a mass of dull grey-black dirt. It is probable that the above sand and a general alteration in the texture of the coal are the chief causes of the inefficiency of weathered coals.

Boiler Explosions.—The Board of Trade report (compiled by Mr. I. B. Walker, of the Marine Department) for the year ended June 30th, 1898, shows that during that period 65 preliminary inquiries and 19 formal investigations were held under the provisions of the 1882 and 1890 Boiler Explosions Acts. The 84 accidents resulted in 37 deaths, 46 people being injured.

Cable Companies' Dinner.—The fifth annual dinner and smoking concert of the cable companies was held at the Manchester Hotel, Aldersgate Street, on Monday evening last. Over 150 guests sat down to the dinner, which was presided over by Mr. E. G. Phillips (superintendent, Commercial Company), while Mr. H. G. Mechen (Direct United States Company) occupied the vice-chair.

City and Guilds Institute.—On 27th inst. the Lord Mayor is to preside at the annual meeting and distribution of prizes at the above Institute at Leathersellers' Hall, and Mr. W. H. Preece, C.B., F.R.S., will then deliver an address to the students.

New Year Honours.—We note from the list of New Year honours that Prof. Wm. C. Roberts-Austen, C.B., F.R.S., assayer to H.M. Mint, has been promoted to a K.C.B. We beg to offer our congratulations to Sir W. C. Roberts-Austen.

Appointment.—We are informed that Mr. W. T. Lynex, who has been for over six years head clerk to the National Electric Supply Company, Preston, has been appointed head of the Leyton District Council's office electric lighting department.

Mr. Robert Hammond and his Portrait.—We are informed that many members of the electrical profession have been recently called upon by a man, informing them that the above gentleman is sitting for a presentation portrait in oils, for which the said man is authorised to collect guinea subscriptions, the subscriber receiving, in addition to the gratification of contributing to so worthy an object, an artist's proof of the portrait. Mr. Hammond tells us that, as far as he knows, the story is a concocted one. He explains that a few months since an artist, unknown to him, pressed him to give him his photograph, on the plea that Mr. Swan, the President of the Institution of Electrical Engineers and other leading members of the profession had done the same, with a view of their enlargement on stone and publication in a series. Possibly the man referred to above is the canvasser for the firm who is publishing the series, but all we can say is, that from the inspection we have made of the artist's proof, it is not by any means a good portrait.

Obituary.—We learn with regret of the death of Dr. Eugen F. A. Obach, F.I.C., F.C.S., M.I.E.E, which occurred on 27th ult., at the early age of 46 years. He was born in Stuttgart, of Swiss parents. In 1875 he obtained his degree of Doctor Phil. at the University of Leipzig. The same year he began his practical career with the firm of Messrs. Siemens & Halske, at Charlottenburg, near Berlin, and in the following year he came to England to occupy a position offered to him by the English firm, Messrs. Siemens Bros. (now Siemens Bros. & Co., Limited) at the Telegraph Cable Works at Woolwich. Whilst temporarily in this country in the course of 1875, he was engaged in superintending, during the Direct United States Cable expedition, some experiments carried out in Ballinskelligs Bay, and continued to follow up electrical questions after he had permanently joined Messrs. Siemens Bros.' works in Charlton. In 1879 he accompanied the expedition on board Messrs. Siemens Bros.' ss. *Faraday*, laying the Pouyer-Quertier trans-Atlantic cable. Dr. Obach afterwards devoted himself mainly to the study of the chemistry of gutta-percha and India-rubber, the result of his extensive and varied knowledge of these substances being embodied in his Cantor Lecture delivered recently before the Society of Arts. Shortly after that time his health failed, and even prolonged rest from work brought about no improvement. He finally sought relief in a cold water cure in Switzerland, but the course of his disease could not be checked. By the advice of his medical attendant he joined the family of his eldest brother in Graz, Styria, where he succumbed. Dr. Obach had been a frequent contributor to the literature of electrical science since 1875, about a score of papers being published in the English and German technical journals or in the proceedings of scientific societies.

Mr. T. Scott Anderson, of Sheffield, informs us of the death of his partner, Mr. H. H. Beit, at the very early age of 26 years. Mr. Beit, who had been educated at Rugby, was an Assoc.I.E.E. He first joined Mr. Anderson as pupil, afterwards taking the position of engineer, and 12 months ago he entered into partnership with him. Mr. Anderson will in future carry on the business by himself. Mr. Beit had been ailing for about three months, but his death was unexpected.

Glasgow Electric Tramways.—Mr. John Young's latest report on the working of the Springburn electric tramways says :—

The drawings for the whole period from October 13th to December 24th have averaged 16·01d. per car mile. If we take the last five weeks, however, during which time we may safely assume that the receipts have reached their normal, the average has been 14·88d. per car mile. For the corresponding five weeks of last year the receipts from the horse cars was 11d. per mile, but the average for the route throughout the period from January 1st, 1897, to October 8th, 1898, was 12·24d. per car mile. Taking the larger figure for the horse cars, the electric cars show an increased revenue of 2·46d. per car mile. It is still rather soon to give a definite figure as the amount of the working expenses under electric traction, as the condensing plant has not yet been in operation, but after including a fair sum for maintenance and renewals, it may be taken that the total working expenses will not exceed 6½d. per car mile. The average working expenses under horse traction may be taken at 8½d. per car mile, although during the last financial year the amount worked out at slightly under that figure. This shows a saving in working expenses for electric, as compared with horse traction, of at least 2d. per car mile. The result, so far as we have gone, has been an increased revenue of 2·64d. (say, 2½d.) per car mile, and a decreased expenditure of 2d. per car mile, being a total gain of 4·64d. (say, 4½d.) per car mile. This gain on the present mileage on the Springburn route (2·40 miles of double track) will amount to £10,000 per annum.

NEW COMPANIES REGISTERED.

Electric Resistance and Heating Company, Limited (60,124).—This company was registered on December 31st, with a capital of £120,000 in £1 shares, to acquire certain patent rights for all countries (except Austria and the Balkan States) for inventions relating to the manufacture of electrical resistance material, to adopt an agreement with the Construction and Investment Company, Limited, and to carry on the business of electricians, electrical, mechanical, gas and general engineers, suppliers of electricity, electrical apparatus manufacturers, &c. The first subscribers (each with

one share) are:—A. Conder, F.S.A.A., Dashwood House, E.C.; J. T. Clary, 46, Devonshire Road, Hackney, shipping agent; W. Chaplin, 191, Camberwell New Road, S.E., secretary; T. G. Fort, Forest Lodge, Ashstead, gentleman; W. Andrew, 38, Hornsey Park, N., book-keeper; F. W. White, Hollywood, Browning Road, Manor Park, E., clerk; G. F. Honig, 10, Alma Square, St. John's Wood, N.W., clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £250; remuneration, £1,000 per annum divisible.

Auxiliary Steam Power Company, Limited (60,104).—This company was registered on December 30th, with a capital of £100,000 in £1 shares, to adopt an agreement with Sinclair C. Lumsden, and to carry on the business of locomotive and other engine builders, machinists, carriage and motor car builders, cycle manufacturers, mechanical, manufacturing, electrical, and chemical engineers, chemical manufacturers, &c. The first subscribers (each with one share) are:—A. B. Connick, 19, Knightrider Street, E.C., clerk; H. Mitchell, 8, Perth Road, N., warehouseman; J. Halford, 31, Womersley Road, Crouch Hill, N., warehouseman; C. F. Adam, Escalonia, Eastbourne, merchant; G. F. Church, 120, Newgate Street, E.C., clerk; G. de G. Griffiths, 34, St. George's Square, S.W., clerk; C. W. Pullen, 71, Elspeth Road, Lavender Hill, S.W., clerk. The number of directors is not to be less than three nor more than six; the first are George A. Hardy, Alfred J. Bale, and Charles F. Adam; qualification, £50; remuneration, £50 each per annum and £75 for the chairman.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Connolly Brothers, Limited (44,277).—This company's annual return was filed on December 9th, when 2,360 shares were taken up out of a capital of £20,000 in £5 shares; 1,798 are considered as paid, and £5 per share has been called and £2,810 paid on the others.

Chatham, Rochester and District Electric Lighting Company, Limited (24,773).—This company's annual return was filed on December 23rd, when 3,890 shares were taken up out of a capital of £50,000 in £5 shares; 1,863 are considered as paid, and £5 per share has been called on the others; £10,135 has been paid, and £83 10s. is in arrears.

Halifax and Bermudas Cable Company, Limited (28,972).—This company's annual return was filed on December 31st, when the whole capital of £50,000 in £5 shares was taken up and considered as paid.

CITY NOTES.

United River Plate Telephone Company, Limited.

A meeting of this company was held last Monday.

Mr. J. Irving Courtenay, the chairman, stated that for several years things were so unsettled in Argentina that it was difficult to say with any certainty how matters would turn out. The directors had therefore felt it necessary to be most conservative in their actions and guarded in their statements, and to allow what they thought to be ample margins for contingencies. The result was that the company had actually been stronger and its prospects brighter than would appear from the mere facts and figures set forth in the reports from time to time. They now hoped and believed that their future was more settled. During the half-year just elapsed there had been an all-round improvement, an increase in subscribers and in revenue, and the outlook justified the anticipation that this satisfactory condition of things would continue. It must be noted, however, that the expenses in the River Plate would be increased this year, chiefly on account of the fall in the gold premium. As an evidence of the thorough nature of the upkeep of plant, which was charged to revenue, he would instance particularly the case of the "Once," one of their principal sub-offices in Buenos Ayres, a centre for 500 subscribers. This office had had a complete new outfit provided, and there had been an entire renewal and alteration of the important wayleaves in its neighbourhood. Other similar alterations and improvements, too numerous to refer to, though not on quite so extensive a scale, had been made elsewhere. It might be thought that a large part of the expenses incurred for such improvements could without impropriety be charged to capital expenditure, but, in the judgment of the directors, the course pursued by this company in charging these outlays to revenue was the correct one for a telephone company to follow, the right theory being that a telephone subscriber was entitled to the best service that could be given, and that the plant, as a part of the working expenses, should be so kept up, renewed, and renovated, at whatever cost might be necessary, as to ensure such a service. It was with this idea that they were proceeding towards a complete renovation of their central system in Buenos Ayres, to be followed, they anticipated, with similar procedure in Rosario and also with the sub-offices in both districts. All of this work, of course, meant a good deal more than the upkeep of existing plant; it meant large capital expenditure as well, but expenditure that would be spread over a considerable period, and they did not doubt that, as needed, it would be possible to obtain the requisite funds. In regard to the Provincial Telephone Company of the Province of Buenos Ayres, in which they had a large interest, steady progress could be reported. The financial position of their company was stronger now than it had ever been before. In anticipation of expenditure on their central office building and otherwise, there had been a further issue of the 5 per cent. debenture stock, and £28,000 had been allotted. The balance of £20,000 was not required at present; probably it might be in another six months or so. There were no resolutions to propose at that meeting.

Electrical Copper Company, Limited.

The second annual general meeting was held last Friday at the offices, 14, Sherborne Lane, Mr. William Jacks presiding. Having referred to the heavy loss which the company had sustained by the death of Mr. H. M. Matheson, who had previously guided the affairs of the company, the chairman said he could not pretend that the report was as favourable as they could have desired it to be. The process was, he said, a perfect success, but when they came to apply it on a large mechanical scale, difficulties arose similar to those which often occurred in connection with new inventions, but which had not been anticipated in their case. Some of the machinery was very complicated, and not suitable for the purposes for which the inventors intended it, but the value of the machinery which had had to be broken up had amounted to only £392. No depreciation had been written off, first because all the machinery was new, and in the second place, in regard to those machines which were defective or unsuitable, claims had been made on the suppliers. He had told them the worst that could be said about the company. A great change for the better had been made within the last three or four months in the mechanical management, by which they had been enabled to introduce economies which had very materially changed the complexion of their accounts. They had only within the last few months overcome the difficulties to be expected in the application of the process on a large scale. They had now produced 100 tons of copper, and they had orders on their books for 30 tons more, many of them being repeat orders. Their policy for the future was to prove to other manufacturers the superiority and cheapness of the company's process, and, without entering into irritating competition with them, to sell them the patents for a lump sum or for a fixed royalty. He concluded by moving the adoption of the report.

Mr. H. B. Fulton seconded the motion, which was adopted.

The Charing Cross and Strand Electricity Supply Corporation, Limited.—The coupons on the 5 per cent. debentures of the above corporation, numbered 1 to 700, due on January 1st, were to be paid on the 2nd inst. and after at the Union Bank of London, Charing Cross Branch, 66, Charing Cross, S.W.

Crompton & Co., Limited.—The directors have declared an interim dividend at the rate of 5 per cent. per annum upon the shares of the company for the half year ending September 30th last.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending December 31st, 1898, were £216 19s.; aggregate to date, £14,476 2s. 10d.

The Bradford City Tramways.—Week ending January 1st, 1899, miles of track open, road mileage, 4·72; number of cars, 16. Receipts, £291 13s. 7d.; total receipts to date, £5,493 8s. 5d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending December 30th, 1898, were £3,194 15s. 4d.; corresponding period, 1897, £2,654 0s. 1d.; increase, £540 15s. 3d.

The City and South London Railway Company.—The receipts for the week ending January 1st, 1899, were £1,036; week ending January 2nd, 1898, £1,050; decrease, £14. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending December 31st, 1898, were £193 12s. 10d.; week ending January 1st, 1898, £159 19s. 8d.; increase, £42 13s. 2d.; total receipts to date, 1898, £8,549 3s. 6d. Miles of track open week ending December 31st, 1898, 3; week ending January 1st, 1898, 3. Car miles run week ending December 31st, 1898, 4,120; week ending January 1st, 1898, 2,833. Number of cars week ending December 31st, 1898, 11; week ending January 1st, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, December 30th, 1898, were as follows:—D. U. T. Co., horse cars, £2,253 9s. 8d.; ditto, electric cars, £632 12s. 11d.; D. S. D. Co., electric cars, £782 0s. 2d.; total, £3,668 2s. 9d; corresponding week last year—D. U. T. Co., horse cars, £2,871 16s. 5d.; ditto, electric cars, £185 2s. 11d.; D. S. D. Co., electric cars, £536 12s. 4d.; total, £3,593 11s. 8d.; increase, £74 11s. 1d.; aggregate to date, £102,480 7s. 5d.; aggregate to date last year, £95,244 4s. 6d.; increase to date, £7,186 2s. 11d. Worked:—The mileage open is 16 miles electrically, 28 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week endin December 21st, 1898, were £237; total receipts to date, 1898, from June 29th, 1898, £6,539. Car miles run, 4,113. Week ending December 28th, 1898, £314; total receipts to date, 1898, from June 29th, 1898, 6,853. Car miles run, 4,062. Miles of track open, 3½. Number of cars, 10.

The Liverpool Overhead Railway Company.—The receipts for the week ending January 1st, 1899, amounted to £1,291; corresponding week last year, £1,357; decrease, £66.

The South Staffordshire Tramways Company.—The receipts for 8 days ending December 31st, 1898, were £954 10s. 4d.; 7 days ending December 31st, 1897, £718 15s. 4d.; aggregate receipts for 52 weeks, £33,142 16s. 7d.; last year £32,924 5s. 3d.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Dec. 28th.	Closing Quotation, Jan. 4th.	Business done during week ended Jan. 4th, 1899. Highest.	Lowest.
127,400l	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	101 —105	100 —104 xd	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	92 — 95	91 — 94 xd	...	...
905,560l	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	65 — 67	66 — 68	67	66
3,047,220l	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	116 —117	116 —117	117	116½
3,047,220l	Do. do. Deferred	Stock	...	...	...	16⅜— 17⅛	16⅜— 17⅛	17⅜	16⅜
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¼— 15⅝	15¼— 15⅝xd	15½	15¼
75,000l	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	...	...	111 —115	110 —114 xd	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	4 %	2⅜— 3½	2⅜— 3½	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	103 —105 xd	104	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	10 — 11	10 — 11	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	10½	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000	50	4½ %	4½ %	4½ %	105 —108%	104 —107%	...	...
60,710l	Direct United States Cable	20	2¼ %	2¼ %	...	11⅜— 12¼	11⅜— 12¼	12⅛	...
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	103 —106	102 —105 xd	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	173 —178	173 —178	175¾	173½
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	104 —107	104 —107	106	...
500,000	Do. Prov. Certs., 50 % paid	...	...	...	...	54 — 57	54 — 57	...	...
89,900	Do. 5 % Debs., repayable August, 1899	100	5 %	5 %	5 %	101 —104	101 —104	...	...
1,432,268l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	124 —128	124 —128	...	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	17½— 18	17½— 18	17 11/16	...
16,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	101 —105	99 —103 xd	...	...
64,400l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	102 —105	100 —103 xd	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	125 —129	125 —129	...	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	101 —105	99 —103 xd	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	102 —105	100 —103	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	104 —107	104 —107	...	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	104 —107	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	4½ %	12¼— 12¾	12¼— 12¾	12½	12 5/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16⅜— 17⅛	16⅜— 17⅛	16¾	...
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	10 %	10 %	28½— 29½	28½— 29½	...	...
150,000l	Do. do. do. do. 5 % Debs.	100	5 %	5 %	5 %	100 —103	101 —104	103	...
97,800	Halifax & Bermuda Cable, 4½ % 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	101 —104	100 —103 xd	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	55 —58	56 — 59	...	...
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	5½ %	6 %	5¼— 5⅜	5¼— 5⅜	5⅜	5¼
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	...	...
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100 —103	99 —102 xd	100½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	105 —108	104 —107 xd	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8 xd	7	...
3,381	Submarine Cables Trust	Cert.	...	...	...	134 —139	134 —139	...	...
58,000	United River Plate Telephone	5	4 %	5 %	6 %	4¼— 4⅜	4¼— 5	4⅜	4 9/16
151,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	104 —107	102 —105 xd	...	...
200,000l	West African Telegraph, 5 % Debs.	100	5 %	5 %	5 %	100 —103	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	102 —105 xd	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3½ %	12¼— 12⅜	12¼— 12⅜	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	8 — 8½	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	nil	¼ %	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	107 —110	105 —108 xd	...	...
88,321	West India and Panama Telegraph	10	⅞ %	1 %	¾ %	2 — 2¼	1⅞— 2⅛	2 3/16	2
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10¼— 10⅜	10¼— 10⅜	10⅜	10¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½— 9	8½— 9⅛	9 3/16	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	106 —109	104 —107 xd	...	...
158,100l	Western Union of U.S. Telegraph, 6 % Ster. Bonds	100	6 %	6 %	6 %	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	11½— 12½	11½— 12½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord.,	5	5 %	5 %	6 %	9 — 10	9 — 10	9⅜	9⅜
60,000	Do. do. do. % Deb. Stock Red.	Stock	4½ %	4½ %	4½ %	113 —115	113 —115	...	...
50,000	City of London Electric Lighting, rd. 40,001—90,000	10	5 %	7 %	10 %	23 — 24	22 — 24	23	22⅞
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	21 — 23	21 — 23	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16½	15½— 16½	15⅝	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	127 —132	125 —130 xd	129	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	nil	nil	nil	12½— 13⅓	12½— 13⅓	13	12⅓
10,000	Do. do. do. Nos. 30,001 to 40,000	10	...	...	...	10 — 11	12 — 13	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14½— 15½	14½— 15½	...	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	...	5 %	5 — 5½	5 — 5½	5½	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	...	4 %	9 — 10	9 — 10	...	...
12,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	9½— 10½	9½— 10½	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	3 — 3½	3 — 3½	...	...
48,050	Do. do. do. 6 % Pref.	5	...	...	...	6 — 6½	6 — 6½	6½	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	102 —104	102 —104	103	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	17½— 18½	17½— 18½	18¼	17 13/16
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	117 —121	115 —119 xd	117⅞	117
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	17 — 18	17 — 18	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7½ %	10½ %	14½ %	16 — 17	16 — 17	16¾	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
50,000	Do. do. 4 % Deb. Stock Red.	Stock	...	...	4 %	105 —108	105 —108	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	2¾— 3	2⅞— 3⅛	3	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	7 %	9 %	12 %	15½— 16½	15½— 16½	16⅜	16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Dec. 28th.	Closing Quotation Jan. 4th.	Business done during week ended Jan. 4th, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3¼— 3¾	3¼— 3¾	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	...	...
30,000	British Electric Traction	10	...	...	...	15½— 16½	15½— 16½	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13 — 13½	13 — 13½	...	...
100,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	119 —121	119 —121	120½	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1⅝— 1⅞	1⅞— 2	1 1/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2½— 2⅝	2½— 2⅝	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	101 —104 xd	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	9½— 10½	9½— 10½	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	112 —115	110 —113 xd	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅞— 10¼	9⅞— 10¼xd	10	...
178,303	Do. do. do. £6 paid	10	...	...	...	5⅞— 6¼	5⅞— 6¼xd	6	...
61,033	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1⅝	1¼— 1⅝xd	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4⅝	4 — 4¼xd	...	...
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 9/16 %	1⅞%	65 — 68	67 — 69	67½	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £4 pd.	10	...	...	...	3½— 4	3½— 4	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	1⅞— 2¼	1⅞— 2¼	2⅛	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	91 — 96	89 — 94 xd	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	6 %	2¼— 2⅜	2¼— 2⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	6 %	4 — 5	4 — 5	...	...
194,023	Do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99	95 — 97	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	6 %	2¼— 2½	2¼— 2½	2 7/16	2⅜
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	2⅜— 3¼	2⅜— 3¼	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	105 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅛— ¼	⅛— ¼	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅛— ¼	⅛— ¼	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	22 — 23	22 — 23	22½	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	...	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	103⅛	102½
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3½%	10 — 10½	10 1/16— 10 3/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅜— 15½	14⅜— 15½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	40	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	102 —105 xd	104	103½
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	111 —114	111 —114	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10—12; 7 % Pref., 11—13.
House-to-House, 4½% Debentures of £100, 103—106 xd.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—14; 1st Preference Cumulative 6%, £5 (fully paid), 7⅜—8¼. Debentures, 103—106%. Dividend, 1897, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, 5/16 to 7/16.
Smithfield Market Electric, 4—5.
*T. Parker, £10 (fully paid), 15⅞—16⅛.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (October 13th, 1898).

MARKET QUOTATIONS, Wednesday, January 4th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£20	£19 10	10/- inc.
a Lead, Nitrate .. .. .. per ton	£23	£23 10	10/- dec.
a „ White Sugar .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¾d.	3¾d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	65/-	65/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..

METALS, &c.	This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
c Brass (rolled metal 2' to 12') basis per lb.	6¾d.	6¾d.	..
c „ Tube (brazed) .. .. per lb.	8¼d.	8¼d.	..
c „ Wire, basis .. .. per lb.	7d.	7d.	..
f Ebonite Rod .. .. .. per lb.	8/-	8/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£68	£66	£2 inc.
g „ Wire (basis price) .. per lb.	8d.	8d.	..
g „ Sheet .. .. .. per ton	£68	£66	£2 inc.
g „ Rod .. .. .. per ton	£68	£66	£2 inc.
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	5/9 to 6/-	6/-	only 3 tons obtainable
h India-rubber, Para fine .. per lb.	4/1	4/1 n. 4/1½ o.	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	44/3	44/3	..
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	45/-	45/-	..
i „ Wire galvanised No. 8 .. per ton	£8 15	£8 15	..
g Lead, English Ingot .. .. per ton	£13 7 6	£13 5	2/6 inc.
g „ „ Sheet .. .. per ton	£14 5	£14 3 9	1/3 inc.
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£7 15	£7 15	..
o Platinum .. .. per oz.	£3 1 6	£3 1 6	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£91 10	£87 10	£4 inc.
g „ foil .. .. per lb.	1/3	1/3	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/5	1/4	1d. inc.
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¾d.	6¾d.	..
j „ Flax, 6 or 8 lea... .. per lb.	8¾d.	8¾d.	..
j „ Hemp, 3 ply 10 lbs. .. per lb.	3¾d.	3¾d.	..
j „ „ Russian, 10 lbs. per lb.	4¼d.	4¼d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£29	£29	..
k Zinc, Sheet (Vielle Montagne bnd.) p. t.	£29	£29	..

a Quotations supplied by Messrs. G. Boor & Co.
b „ „ „ The British Aluminium Co., Ltd
c „ „ „ Messrs. Thos. Bolton & Sons.
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co Ltd
g „ „ „ Messrs. James & Shakspeare
h „ „ „ „ Jackson & Till
i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ „ Henry C. Yeo & Co.
k „ „ „ „ Morris Ashby, Limited.
l „ „ „ „ Sanders, Wake & Co.
m „ „ „ „ W. T. Glover & Co., Ltd.
n „ „ „ „ P. Ormiston & Sons.
o „ „ „ „ Johnson. Matthey & Co., Ltd

INSTITUTION OF ELECTRICAL ENGINEERS.

"ELECTRIC INTERCOMMUNICATION IN RAILWAY TRAINS." By W. E. LANGDON, Vice-President. Paper read December 15th, 1898.

(*Continued from Vol.* 43, *page* 992.)

THE coupling adopted by the author for the Midland train is shown in fig. 10. The electrical portion consists of two plates of metal, insulated the one from the other, to which the two wires forming the communication are attached. These plates are so cut that that belonging to one part of the coupling shall dovetail into that belonging to the other portion. The two plates are so fixed within an iron

FIG. 10.

case, formed after the fashion of, but smaller than, the vacuum brake coupling, that that applicable to the positive wire of the one coach shall engage with that applicable to the similar pole of the connecting coach. It is thus impossible to cross the wires, while the one coupling serves for the two wires.

The vacuum brake form of coupling has been selected as the protecting and guiding cover, for the reason that, the mode of coupling it up being so well known, no difficulty can possibly attend its application to the purpose of an electrical coupling. The wires are carried from the contact plates to the end of the vehicle in tubing similar in character, but smaller than the brake tubing. The wires of each vehicle terminate on an insulated plate fixed to each end of the carriage, so that any changes needed may be readily effected. The wires throughout are fully protected from moisture.

Samples of all these couplings will, it is hoped, be placed upon the table.

3.—THE MEANS FOR CLAIMING THE ATTENTION OF THE OFFICIALS IN CHARGE OF THE TRAIN.

In the Brighton Company's carriages this is secured by the operation of a knob (fig. 11). This knob forms the handle of a commu-

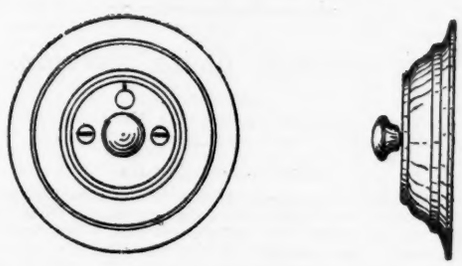


FIG. 11.

tator, and on being pulled out it, by means of the commutator, connects the line and earth wires. It is fixed in the centre of the partition which divides one compartment from another. Each compartment is thus provided with a means of raising an alarm from one position. On the knob being pulled out to a certain extent, it becomes locked and requires the presence of the guard to release it. The bells continue to ring so long as the commutator remains extended. The Brighton Company employ no outward indicator to identify the vehicle from which the alarm has been raised. It is the duty of the guard to examine the commutators throughout the train until he finds that which has been pulled. It is not understood that any difficulty has attended the absence of such an indicator.

In the South-Eastern Company's stock considerable improvements in the mode of operating the alarm commutator have been effected by Mr. Leonard. The commutator is placed over one of the quarter windows, and is provided with a knob, as in the Brighton Company's trains, but this knob is arranged to pull *downwards* (see fig. 12), and

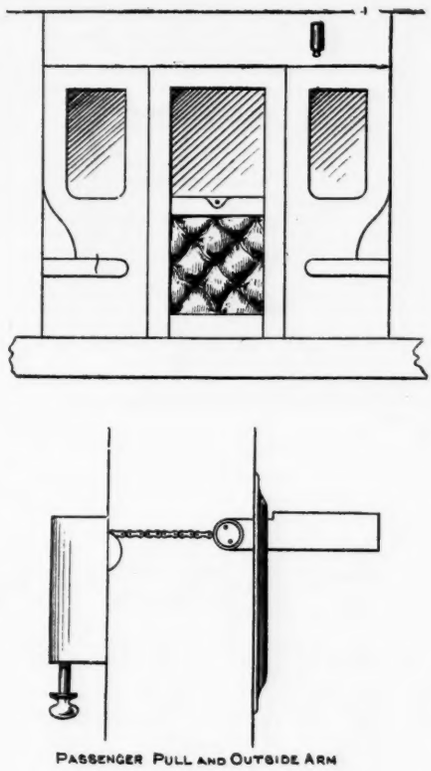


FIG. 12.

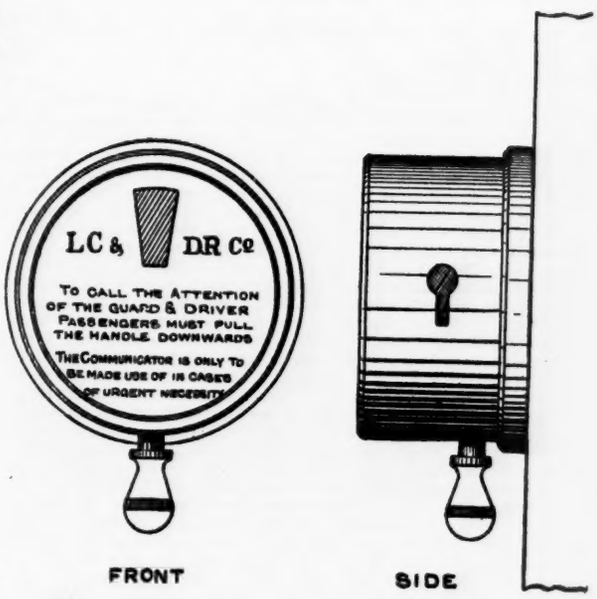

LC & DR Co
TO CALL THE ATTENTION OF THE GUARD & DRIVER PASSENGERS MUST PULL THE HANDLE DOWNWARDS
THE COMMUNICATOR IS ONLY TO BE MADE USE OF IN CASES OF URGENT NECESSITY
FRONT
SIDE

FIG. 13.

is thus more readily operated than if it had to be pulled outwards. Each compartment has but one point from which the alarm may be raised. Each first-class compartment, and nearly all second-class compartments, are provided with an outside indicator, but to the third-class one indicator only is allotted to each carriage.

Fig. 13 illustrates the design of the commutator employed by the Chatham and Dover. Each compartment is provided with one com-

mutator fixed in the centre of the division. There is no indicator to show the source of alarm.

The commutator in each instance is of the most simple character—merely connecting the line and earth wires or the two line wires—at the moment of sounding the alarm, becomes locked, and can only be released by the guard, either from the outside or the inside of the vehicle. The object in view in this arrangement has been to place at the disposal of the passenger a means of communication, accessible

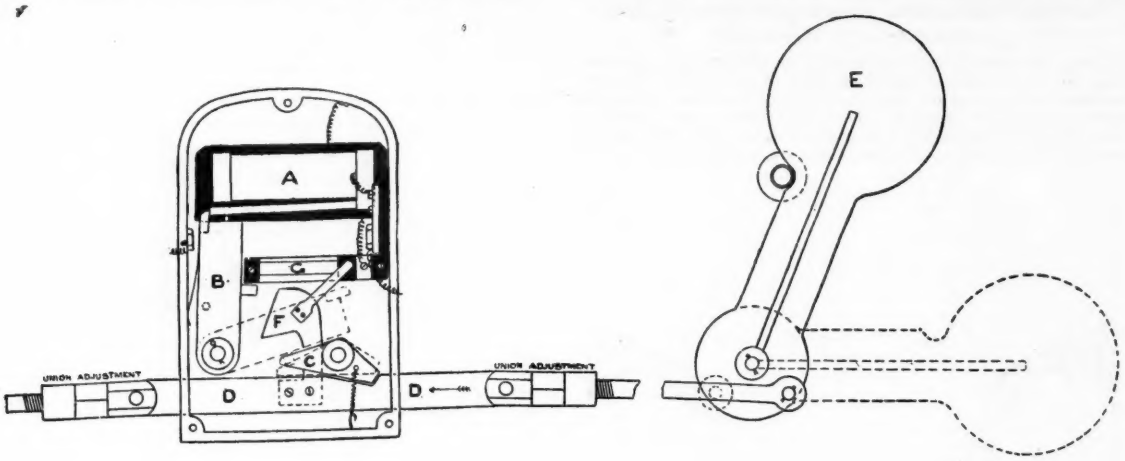


FIG. 14

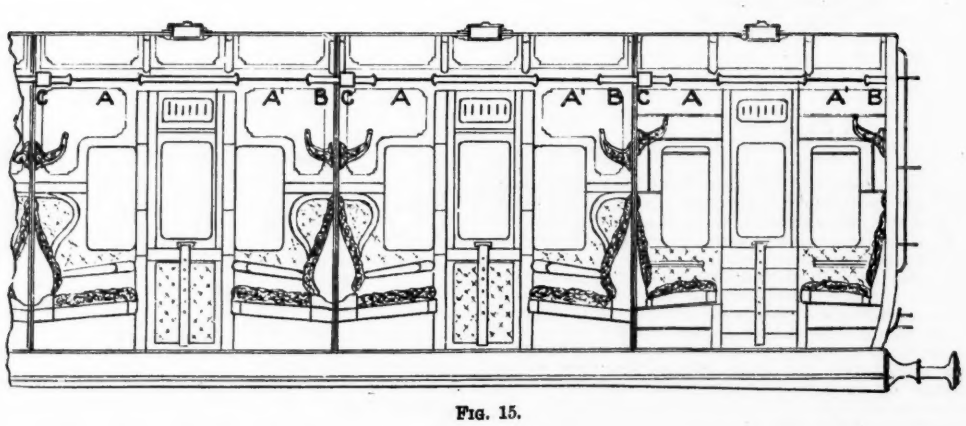


FIG. 15.

and, where used, discharging mechanically the indicator affixed to the outside of the vehicle or compartment as may be arranged. The commutator once operated remains locked until re-set by the guard.

The coaches, which have been fitted by the Great Eastern, are, in like manner, provided with a commutator fixed in the centre of the division between the compartments. The user turns a switch handle capable of being moved in either direction—to the right or to the left—which closes the circuit. Each coach is provided with an outside indicator on either side of the vehicle for the purpose of indicating whence the alarm is raised. On the circuit being closed by any one compartment, the current passes through the indicators and discharges them. The principle upon which this indicator is constructed is that of the Sykes signal reverser. The current energises an electro-magnet, A, fig. 14. On the armature being lifted, a heavy bar, B, is discharged, and, falling upon C, forces it out of the notch, in which it normally rests, in the bar D. E is the indicator, and it is heavily weighted, so that, on C being lifted out of D, it pushes the rod before it in the direction of the arrow. As D is moved forward it carries with it the *replacer*, F, which is attached to it, placing the spring which projects from it in contact with G, thereby short circuiting the electro-magnet. F at the same time forces back B into its normal position, where it is again held by the armature of A. On the guard lifting E into its upright position, the rod, D, is drawn forward until the detent or locking piece, C, falls into its slot, when the entire arrangement is reset and ready to be again discharged. The readjusting portion, F, has, along with D, been moved forward, and the short-circuiting spring attached thereto again rests upon an insulated part.

The means adopted for raising the alarm in the trains running on the Midland forms a marked departure from the course generally pursued hitherto. A flexible steel wire (fig. 15) is carried inside a metal tube along each side of the carriage over the doors and quarter lights. This wire has one end made fast at, say, B, in each compartment, or at the end of the coach. The other end, C, is attached to the lever of a commutator capable of being operated in either direction. The wire, covered by a fabric suitable for handling, is exposed for some 12 or 15 inches at A, over each quarter light. On the wire being pulled from any one of the exposed parts, the commutator lever is operated, a disc on the outside of the carriage is discharged, the circuit is closed and the bells set ringing. Each compartment has thus *four points from which the communication may be brought into operation.* Each coach has an indicator on either side, and if necessary each compartment may be so provided. The commutator, from the interior of the vehicle at not less than four points of the compartment, in such a position that it shall be out of the reach of irresponsible persons. If preferred, the cord might be entirely enclosed and operated by a pull-down knob or handle, but it would, of course, be more costly.

(To be continued.)

AN IMPERIAL CABLE SERVICE.

(*Concluded from page* 969, *Vol.* 43.)

Profit in Low Charges.

When the Government assumed control of the inland telegraphs of the United Kingdom, it was found possible greatly to reduce charges. In 1869, the year before the transfer, less than 7 million messages were carried. At the transfer the rate was reduced to 1s. per message; the traffic immediately increased nearly 50 per cent., and continued increasing, until, in the tenth year, 29 million messages were transmitted, with a surplus of revenue over expenditure of £354,060. In another decade the total annual business equalled 94 millions, the operations still resulting in a surplus of £251,806, although the charge for a message had been meanwhile reduced from 1s. to 6d. It is indisputable that high charges restrict the utility of sea cables as well as of landlines, while low charges have the opposite effect. A few years ago the tariff of charges between Australia and London was 9s. 4d. per word. The proposal to establish the Pacific cable and the discussion which followed, led to the cheapening of the rate to 4s. 9d. per word. In 1890, the year before the rates were lowered, the gross business consisted of 827,278 words. Last year (1897), it had increased to 2,349,901 words. In 1890,* with high charges, the revenue was £567,852, or £236,384 in excess of 1890, when the highest rates were exacted.

The utility of the telegraph may be measured by the time gained over the post, and the success of the telegraph service of the United

* There is apparently some misprint or omission here.

Kingdom must be accepted as convincing evidence of its utility and value, for the gain in time is, in this case, measured by hours only. Its striking success in this instance may be largely owing to State control, but, whatever the cause, it is obvious that if, under similar conditions, weeks were gained instead of hours, the utility of the telegraph would be proportionately increased, and its value as a means of communication correspondingly enhanced. There is another immense advantage, not generally known to the public, which can be claimed for telegraphy. It is the fact that, within certain limitations, the actual cost of transmission is but little affected by distance. While the cost of carrying letters is in proportion to the distance traversed, the same rule does not apply to the electric wire. With a properly equipped telegraph system the actual expenditure incurred in transmitting a message thousands of miles is practically no greater than in sending it 10 miles. Obviously, therefore, the principle of "penny postage"—that is to say, a low uniform charge for all distances, is applicable even more fully to ocean telegraphy than to the Imperial postal service. With these considerations before us, a moment's reflection leads to the conviction that this wonderful agency, the electric wire, places within our reach, if we have the wisdom to accept it, an ideal means of communication for the world-wide British Empire.

Wisdom of State Control.

Thirty years ago the British Parliament, for reasons the soundness of which experience has fully confirmed, determined that the State should assume control of the inland telegraph system of the United Kingdom. To-day there are incomparably stronger reasons for State control being exercised over a cable system for the whole empire.

The proposal is not altogether new. If the proceedings of the Colonial Conference of 1887 be referred to, it will be found that an Imperial telegraph service was foreshadowed in the discussions. To those I would refer, and especially pages 225 to 228, 339 to 341, and 513 to 520. In these discussions the delegates from the Cape of Good Hope, Natal, Australia, New Zealand, Newfoundland, and Canada took part. Again, at the Colonial Conference of 1894, the proposal was set forth in some detail, and the advantages of an all-British system of telegraphy around the globe pointed out. On that point I beg leave to direct attention to the proceedings of the Ottawa Conference, and more particularly to pages 88 to 90, inclusive; likewise to the proceedings of the second congress of the Chambers of Commerce of the Empire, and more especially to a letter from the Ottawa delegate (July 1st, 1892) to the President, Sir John Lubbock.

The proposal to complete the telegraphic circuit of the globe has no doubt suggested itself to many persons. Among those who have written on the subject may be mentioned Sir Julius Vogel, at one time Postmaster-General of New Zealand; the late Mr. F. N. Gisborne, Superintendent of Telegraphs for the Canadian Government; Sir George Baden-Powell, M.P., London; Mr. J. C. Lockley, of Nhill, Australia; and the veteran postal reformer, Mr. Henniker Heaton. At the Cape, Mr. Jan Hendrick Hofmeyer has given the matter his strongest support.

Projected Cable System.

It may be laid down as an essential condition of an Imperial cable service that none of the lines should touch foreign soil, and that they should be placed so as to avoid shallow seas, more especially those seas in proximity to any country likely at any time to prove unfriendly. In describing generally the route which would best comply with these conditions, I shall commence at Vancouver, for the reason that up to this point telegraphic connection with the Imperial centre in London is already assured, without being dependent on any foreign power. First, we have direct telegraphic connection across the Atlantic by a number of cables, and it is a mere question of cost to lay additional trans-Atlantic cables whenever they are wanted. Secondly, we have a trans-Continental telegraph from the Atlantic coast to Vancouver, extending along the line of the Canadian Pacific Railway, and all practical telegraphers will recognise the great advantage of this position. By having the wires hung within the sight of passing trains, the telegraph can be frequently inspected with the greatest possible ease, the faults, when they occur, can speedily be repaired.

Commencing at Vancouver the cable would cross the Pacific to New Zealand and Australia; from Australia the main line would cross the Indian Ocean to South Africa; from South Africa it would traverse the Atlantic to Canada, where it would connect with the trans-Atlantic lines. Such a system of cables would complete the telegraphic circuit of the globe, and would constitute a base for connecting every one of Her Majesty's possessions and naval coaling stations (Gibraltar and Malta excepted) by the most perfect means of conveying intelligence at our disposal. Moreover, the connection would be formed by a system of all-British deep-sea cables in the position where they would be least vulnerable. This Imperial cable system may be considered in three divisions.

1. Cables in the Pacific Ocean.

The cable from Vancouver would first find a mid-ocean station at Fanning Island, second at Fiji Islands, third at Norfolk Island; at Norfolk Island it would bifurcate, one branch extending to New Zealand, the other to the eastern coast of Australia.

There are many islands in the Pacific, some under British, others under foreign flags; in course of time these islands could be served by branches as circumstances may require. The landlines of Australia would complete telegraphic connection with the western coast, or it may be deemed expedient to substitute a cable for the landlines over that portion of the interior between Adelaide and King George's Sound.

2. Cables in the Indian Ocean.

From King George's Sound, or other point in Western Australia, the cable would extend to Cocos Island, thence to Mauritius, and thence to Natal or Cape Town, as may be found expedient. Cocos would become an important telegraphic centre; it would be a convenient point for connecting Singapore by a branch cable. Singapore is already in connection with Hong Kong by an all-British cable *vid* Labuan, and Her Majesty's Government can take possession by giving 12 months' notice. India could be reached by a branch from Cocos to Colombo or Trincomalee in Ceylon. At Mauritius, a connection would be formed with the existing cable to Seychelles, Aden and Bombay.

3. Cables in the Atlantic Ocean.

In order to avoid the shallow seas along the west coast of Africa, Spain, Portugal and France, it is proposed that the cable should extend from Cape Town to Bermuda, touching at St. Helena, Ascension and Barbados as mid-ocean stations. At Bermuda a connection would be formed with the existing cable to Halifax, and at that point with the Canadian and trans-Atlantic lines.

Much prominence has been given to a proposal to connect England with the Cape by a line of cable touching at Gibraltar, Sierra Leone or Bathurst, Ascension and St. Helena. I pointed out in my letter of last December to Sir Wilfrid Laurier that there are grave objections to the northern half of that route, as "the cable, of necessity, would be laid for some distance in shallow seas, where it would be exposed to injury from various causes, and where, too, the agent of an unfriendly nation, or, indeed, an evil-disposed fisherman, would have it in his power to destroy the cable with ease, totally unobserved. For hundreds of miles it would be exposed to such risks."

The route now proposed from Ascension to Great Britain is certainly less direct, but the cable would be much less in jeopardy, and to this may be added, the advantage which would result in bringing the West Indian possessions within the Imperial telegraphic circle.

Table of Distances.

In order that some estimate may be formed of the cost of such an undertaking, I submit the following approximate distances which each group of cables would require to cover:—

	Knots.	Knots.
1. In the Pacific Ocean, from Vancouver to Australia and New Zealand ...		7,150
2. In the Indian Ocean, from Western Australia to South Africa—		
Main line	6,500	
Branch to Singapore	1,100	
Branch to Colombo	1,500	
		9,100
3. In the Atlantic Ocean, from South Africa to Bermuda		6,600
Total		22,850

The total distance for which new cables would be required (of which 20,250 knots would be in the main line, and 2,600 knots in branches) may be roughly placed at 23,000 knots, and the cost (including the branch to Hong Kong) between 5 millions and 6 millions sterling.

I have long advocated the first division of the proposal—the establishment of a cable from Canada to Australasia as a State work. I have felt that it would be the forerunner of an all-British telegraph system, embracing the whole Empire. As a State undertaking, I am satisfied that the Pacific cable would be a complete commercial success, and that so soon as it so proved the cable extension to South Africa and India would follow.

One advantage peculiar to a globe-encircling system of cables will be apparent, each point touched would be in connection with every other point by two routes extending in opposite directions. This feature is of special value, as it practically constitutes a double connection in each case. The projected system of all-British cables with its branches would thus doubly connect the following fortified and garrisoned coaling stations, namely, Hong Kong, Singapore, Trincomalee, Colombo, Aden, Cape Town, Simons Bay, St. Helena, Ascension, St. Lucia, Jamaica, Bermuda, Halifax, Esquimalt, King George's Sound, and Thursday Island. The following "defended ports" would likewise be connected, viz., Durban, Karachi, Bombay, Madras, Calcutta, Rangoon, Adelaide, Melbourne, Hobart, Sydney, Newcastle, Brisbane, Townsville, Auckland, Wellington, Lyttletown, and Dunedin.

Would it not be in the interest of a great commercial people to have these and all such points in the outer empire connected by a means of communication so perfect as the electric telegraph? Is it not a matter which vitally concerns every British community around the globe? Is it not in their common interest that they all should be placed in possession of the speediest medium of conveying intelligence the one to the other, free from the burden of high charges?

Self-Supporting System.

That a State-owned Pacific cable is the key to the situation, I am firmly convinced. Exhaustive examinations have proved its entire practicability. Its financial aspect has been minutely investigated by business men of the highest rank. The Canadian Government appointed Lord Strathcona and the Hon. A. G. Jones for the purpose, than whom there are no men with stronger business insight. Their report is in the possession of the Government, and it takes the most favourable view of the project. As a State undertaking it would be self-supporting from the first year of its establishment, and would admit of charges being lowered year by year. That the final outcome of the laying of this cable would be an Imperial telegraph service there can be little doubt. I am satisfied that the Pacific cable would prove to be the entering wedge to remove for ever all monopoly in ocean telegraphy, and free the public from excessive charges; that it

would be the initial link in a chain of State cables, encircling the globe, with branches ramifying wherever the British Empire extends, and that it would be the means of bringing into momentary electric touch every possession of her Majesty.

In 1837 Rowland Hill, in advocating uniform penny postage for the United Kingdom, pointed out how desirable it would be to have the same low rates as on inland letters charged on letters passing to and from the colonies. This remarkable man concluded with the memorable words: "There is perhaps scarcely any measure which would tend so effectually to remove the obstacles to emigration, and maintain that sympathy between the colonies and the mother country which is the only sure bond of connection, as the proposed reduction on the postage of colonial letters."

Had Sir Rowland Hill known of the means of instantaneous communication which since his day has been placed at our command, he assuredly would have viewed it as the most civilising agency of the century. He would have seen that while promoting the activities of trade and commerce and improving the well-being of the human race, nothing would more tend to deepen the sympathies of our people and make firm the foundations of the empire than the adding to a universal penny postage the incalculable advantage of a State-controlled ocean telegraph system encircling the globe.

Holding the views which I have ventured to submit, I feel that in the public interest I should greatly err if I failed to seek an opportunity of giving expression to them.

Sandford Fleming.

STEAM ENGINE GOVERNORS.*

By JOHN DAVIDSON.

(*Concluded from Vol.* 43, *page* 967.)

As the Proell governor lends itself exceedingly well to the arrangement just described, I give an example of the same in fig. 7

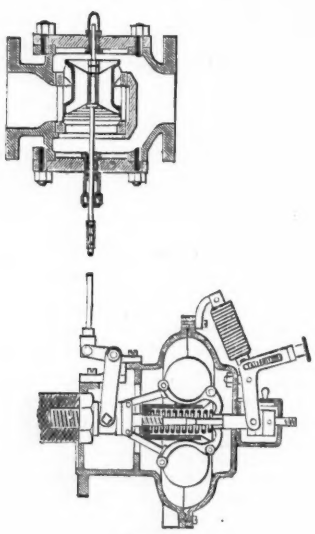


Fig. 7.

as fitted to a vertical engine, the governor being fixed to the end of the crankshaft. A speeder gear is also shown, so that the speed can be adjusted while the engine is running.

In nearly all throttle valve governors, the weights are driven through the links carrying them, these links being placed so as to oscillate on their pins, in a direction at right angles to the path of rotation, consequently when a change of load takes place, and with it a change in velocity of the governor, a twist is put on the links at the joints, and creates friction just at the moment the weights should be most free to move to check any further increase of the variation in speed. There is room for improvement no doubt in the mode of carrying and driving the weights in many throttle valve governors now in use, as I think a good deal of the sluggishness in these governors is due to defective arrangements of the joints, and not solely upon the distance away from the cylinder of the throttle valve. If the inertia of the weights was more effectively used in this type of governor, most likely it could be made more certain and prompt in action, and to compare more favourably with automatic expansion governing in this respect. When a load is thrown off suddenly, still there would be the steam between the throttle valve and the cylinder to have effect, so how prompt the governor was, but even this could be got over by fitting the throttle valve inside the main piston valve, if a piston valve be used to distribute steam to the cylinder. In this way the governor could be made to act directly upon the steam admitted to the cylinder, and be independent of the volume of the steam chest.

Variable Expansion Governors.—Governing by means of trip gears, &c., as in Corliss engines and others of this class, are really included under this head, but I cannot, within the limits of this paper, describe them in detail, so I will take a few points in connection with automatic expansion shaft governors, and give a few examples.

Governors of this class control the engine by varying the travel of the valve, and also the angle of advance of the eccentric, and so the point in the stroke at which the steam is cut off. They are in most cases of a more massive design than those just considered, owing to the fact that they have to drive the valve or valves of the engine as part of the engine proper, and at the same time vary the travel, &c., to regulate the quantity of steam required. Some of them are of a very complicated and cumbersome design, owing to the great amount of work they have to do in driving the valve, independent of the power required to effect a change in the gear.

Most of them chiefly consist of revolving weights controlled by springs, the acting force being the centrifugal force of these weights, which are coupled by links, &c, to the eccentric, and cause it to vary its position.

In this type, as in all others, great care should be taken in the design of the mechanism, so as to reduce as much as possible the friction due to the forces exerted in the governor itself. That means that the forces exerted by the weights should act as directly as is convenient to the arrangement upon the portion to be moved, and not have to be transmitted through many joints, which often leads to enormously magnified forces upon the joint pins themselves, causing unnecessary friction and great wear and tear, and from this comes the yarn that shaft governors are always getting out of order and giving trouble, while a throttle, which costs much less, will buzz away for years without anything being done to it but clean it down now and then.

As I have just mentioned, governors of this type are of necessity more massive, and therefore the centrifugal force of the weights, &c., becomes much greater; but this force should be kept as much as possible off the working joints, by arranging the springs in direct opposition to the centrifugal force. There are practical difficulties in the way of this in may cases, though, as the springs must then act directly in a line through the centre of the shaft, and also it necessitates very long springs, but approximations to this can be made, which will materially help in this direction. This question of internal friction of the governor is very important, and increase of pressure on pins means larger pins, with the friction acting at a larger radius.

Again, beside the centrifugal force of the weights, acting as the moving force during a variation in speed, the weights by their own inertia tend to keep on at the same rate of speed for an instant. This inertia effect may be arranged to act with, or give, as it were, an initial force to the centrifugal force, or it may be arranged to act in opposition, making the governor more sluggish in responding to a change in velocity, which is not beneficial to good governing, so it is advisable to pivot the weights in such a way that it may help the centrifugal force. In many governors in use, this inertia effect of the weights is simply absorbed by putting pressure upon the fulcrum pins, while in others it acts in direct opposition to give quick governing.

With a sudden change of load, the inertia effect is sufficient to change the position of the weights, even against the centrifugal force, so when it acts in opposition to the centrifugal force, it has a most serious effect, depending upon the suddenness of the change.

I will now describe a few examples taken from actual practice.

Fig. 8 shows the governor used on the Westinghouse engine. To

Fig. 8.

the wheel or drum is pivoted the eccentric at A. The eccentric swivels with this pin, the path described, being an arc struck from the centre of the pin, and is so arranged as to give a nearly constant lead from the in position to the mean, and then to decrease to no lead at the out position or the weights. These weights, W, are pivoted at B, and are controlled by the tension springs, S, and are connected to one another by the link, L, so that they will move with one another, and precisely the same amount. The movement of the weights, due to centrifugal force, is communicated to the eccentric by the link, C, which is connected at one end to the weight, W, and at the other to a lever, which is keyed to the pin, A. The eccentric is also keyed to this pin, so as the weights move out, as the speed increases, the eccentric is caused to swivel nearer to the centre of the shaft. The whole of the governor gear is enclosed in a drum filled with oil. This is

* Paper read before the Salford Science Students' Association at the Royal Technical Institute, Salford.

purely a centrifugal governor, and, considering all that has to be done is to move the eccentric, it seems a round-about way of doing it.

Fig. 9 shows a diagrammatic sketch of Moore's patent crankshaft

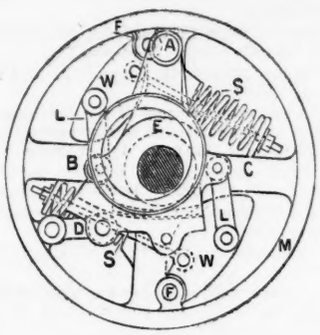


FIG. 9.

governor. To the shaft is fixed the tripod, A B C. From the pin, A, is swung the eccentric, E. The weights, W, are pivoted to the wheel, M, at F, the compression springs, S, controlling the position of the same being also attached to this wheel, which is left loose on the shaft, and is connected only to the fixed portion through the links, L, being fastened to the weights, W. As the weights fly out, due to centrifugal force, the wheel, M, revolves with them, through a small angle on the shaft, and this motion is communicated to the eccentric by means of the link at D, causing it to move nearer to the centre of the shaft and reduce the travel of the valve. On further examination, you will see that as the engine increases or decreases in speed, this wheel, loose on the shaft, tends to go on revolving at the same rate of speed, and due to its momentum helps the centrifugal weights to move either in or out as the case may be. In this arrangement you see both the centrifugal force and the momentum of the wheel rim act together to make a change in the valve gear, tending to make the governor prompt in action, and giving it more power to effect a change in position of the valve gear. This is a very ingenious arrangement, the only drawback being the fearful complication it leads to.

Fig. 10 represents the Robinson's patent shaft governor, and it is

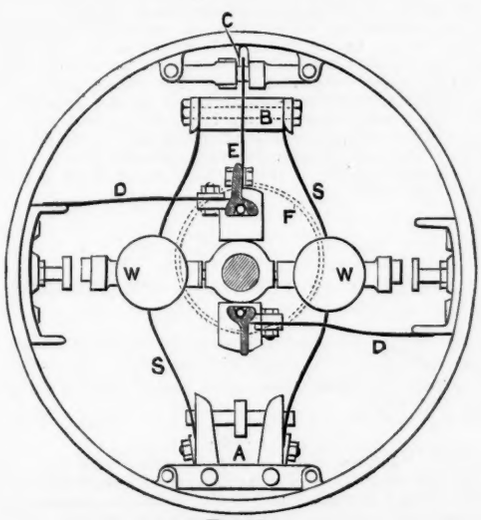


FIG. 10.

of an entirely different construction to the last two examples. The principal feature of this governor is the absence of working joints, these being entirely dispensed with, and flexible flat steel bars being substituted which take the place of the joints, and serve the purpose of springs to control the weights as well. The governor proper consists of two weights, W, mounted on two bow-shaped flat steel bars, S, rigidly fixed to the wheel at one end, A, and joined together at B by a cross piece. As the weights move out the two spring bars, S, bow still more, and draw the loose end, B, towards the centre of the shaft. This cross piece is connected to the eccentric, F, by means of a thin strip of steel, E, the end remote from the eccentric being suitably guided, as shown at C. The eccentric is hung on two other strips of steel at D, and has a straight line motion, the movement of the cross piece, B being communicated to it by the strip E.

As there is only one part in this governor that can give friction, viz, at the slide C, it should not give much trouble, providing the springs are good, and well fitted.

In fig. 11 is shown the Begtrup patent shaft governor, Messrs. Browett, Lindley & Co., being the sole licensees for this country. The great aim in designing this governor has been simplicity, and it could not be much more so. As will be seen, the eccentric and weights are combined in one mass of metal, the whole being pivoted on a pin fixed in the wheel at P, and a spring connected to this mass at F, and to the wheel at B, constitutes the whole governor. There are two weights, W W_1, each at the end of a bar, the weight, W_1, being made slightly heavier than W to form the centrifugal weight of

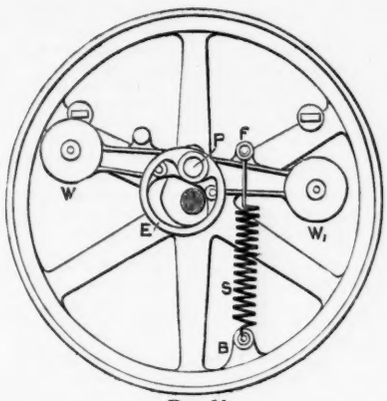


FIG. 11.

the govenor, and is controlled by the spring, S. The eccentric is fastened to the bar at E. As the speed increases, the weight, W_1, tends to fly out, and so turns the bar on the pin, P, and with it the eccentric, bringing it nearer to the centre of the shaft. You will also see that the inertia of both weights assists the centrifugal force to effect a change in position of the eccentric, so in this simple governor is contained all that has been aimed at in designing some of the complicated mechanisms in use at the present day.

ELECTRIC TRACTION SCHEME IN FRANCE.

THE Orleans Railway Company, of France, are extending their line in Paris as far as the Quai d'Orsay, a length of 3,700 m., of which 3,100 are in tunnel, and some other form of traction than steam will be necessary from the station Austerlitz, which has hitherto been the terminus. The change of engine which will be necessary at this station need not occupy two minutes, and this time will be needed for the usual stop there, which cannot well occupy less than two minutes, because of the amount of traffic to be dealt with. A few special trains may, perhaps, be run through with their ordinary engines without stoppage at Austerlitz, because they will not be sufficient to vitiate the air of the tunnel or station. The electric locomotive may remain indefinitely in the tunnel and new terminus, whereas if steam locomotives were allowed in they would have at once to run out after they had run in their train, and in this way the traffic would have been unnecessarily increased 58 per cent.

Already the company were contemplating for general purposes a 750 kw. electric station for lighting the stations of Austerlitz and Ivry, and it seemed feasible to combine in one station both light and power. We have already given an abstract of the report of the engineers sent to examine traction schemes in America. These gentlemen reported of course most favourably, and *L'Industrie Electrique* states that the French Railway requires nothing which has not already been carried through on parallel lines in America, and that for the short distance involved the electrical traction will cost less than steam.

The system chosen should be the continuous current at 500 or 600 volts if the works can be placed near the line. But the station had to be placed 5 km. from the Quai d'Orsay, and high tension with transformers became more economical.

Triphase current has been chosen as applicable to all uses, and the company contemplate later its use in the work-shops at Ivry. There are 150 full or empty trains per day, also lighting, drainage pumps, and a number of other motors for lifts, capstans, and vehicles between the Quai and the fortifications, a distance of 6 km. This current will be produced at 5,500 volts 25 ~ per second by a plant installed in the goods depot at Ivry, near the Tolbiac, 5,300 m. from the Quai. The primary circuit is not to be used without or with reduced tension except in case of a few regular duties as in certain pumps. The locomotives and the lighting, which is chiefly by closed arcs, will be worked by continuous current obtained by transformation of the triphase. This continuous current will have a tension of 550, and will be generated in sub-stations, one at Austerlitz and the other at the Quai. The lighting current is quite separate from the power circuit. The sub-stations each contain a powerful accumulator normally on the power circuit, but capable of being thrown on the light circuit. The Ivry generator plant contains two generators of 1,000 kw. The buildings are to be at once constructed with a view to the installation of a third set.

The traction current is got by rotary converters, which receive at

550 volts, to which it has been first transformed by fixed transformers.

There are two rotaries of 250 kw. each, running at 500 revolutions, and they will be so coupled as to allow the batteries to furnish any necessary excess of power at short periods of heavy load.

The lighting circuits are to be fed at 500 volts by six transformers of 100 kw. rotary type, placed in pairs at the two sub-stations and the works at Ivry. They are to consist of a synchronous triphase 5,500-volt motor coupled on the same spindle as a continuous current 500-volt dynamo. The employment of these is to free the lighting circuit of any sudden changes which exist on the power circuit. The accumulators have a capacity of 1,100 ampere-hours for one hours' discharge. They will deal with fluctuations of traction, will regulate the running of the works, and in case of interruption of the primary current will keep the lighting going for several hours. The primary conductors are cables of three wires strongly insulated and armed, either buried or placed in masonry conduits. The secondary traction current will be served by a third rail placed on blocks of parsffined wood placed on the sleepers with a rail return. The third rail may be on either side or midway of the rails, and the locomotives will have three rubbing blocks at each end, and also will be provided with means for taking current from above also, as the company contemplates this system in places.

Eight locomotives are intended, each of 8-wheel type, with a motor on each axle, and in general form like the American machines at Hoboken, which themselves were derived from those at Baltimore. Each motor is geared to its axle by a simple gear as usual in tramway motors.

The normal power of a locomotive will be 500 kw., the weight about 40 tons, without surcharge, and 45 or 46 tons with this addition, a weight necessary to draw 250-ton trains, including the locomotive, from the Quai to Austerlitz in seven minutes, without stop, and to start a 350-ton train up a grade of 11 per cent.

The lighting and small motors will absorb 1,720,000 kw.-hours annually. Traction is expected to require 1,420,000 when dealing with 150 trains per day. The seven minutes' run is expected to require 27 watt-hours per ton km., absorbing 650 kw. at starting, and 250 when running. The total cost of the whole electrical installation is estimated at 3,058,000 francs (£122,320), and it is expected to be at work by the end of 1899. It appears from this that the French do not anticipate any difficulty in a double system of steam and electricity any more than the Americans find such difficulty.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

26,738. "Improvements in conduit inspection fittings for electrical wiring." T. Taylor. Dated December 19th.

26,787. "Improvements in electric fuses for use in blasting or other like purposes." H. G. Tidehurst and B. T. Moore. Dated December 19th.

26,789. "Improvements in and relating to electrical incandescence lamps." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated December 19th. (*Complete.*)

26,790. "Current conducting connection between electrical conductors." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated December 19th. (*Complete.*)

26,806. "Improvements in steam or electric after-steering gear for ships." W. B. Thompson. Dated December 20th.

26,807. "Improvements in electric switches." F. L. Monkhouse. Dated December 20th

26,858. "The oxidised-carbon electric power process." R. H. Dunn. Dated December 20th.

26,886. "Improved means for manufacturing metallic ribbon especially applicable for battery electrodes." The Porous Accumulator Company, Limited, and J. C. Howell. Dated December 20th. (*Complete.*)

26,914. "Improvements in dynamo-electric machines, electric motors, and the like." A. Collavet. Dated December 20th.

26,930. "An automatic telephone exchange and means relating thereto." E. Preismann. Dated December 20th. (*Complete.*)

26,947. "A new process of treatment and method of working electric accumulators." P. Gadot. Dated December 21st.

26,948. "Improvements in or relating to the brushes of dynamo electro-motors and the like." J. P. Hall. Dated December 21st.

26,984. "An improved change-over switchboard and light indicator for use in connection with electric lights on board ship." J. E. Spagnoletti, J. Crookes, and J. Lawrence. Dated December 21st.

27,009. "Interchangeable electric display apparatus." W. L. Wise. (G. L. Mason, United States.) Dated December 21st.

27,018. "An electro-chemical method of disintegrating rocks carrying minerals." C. H. Logan. Dated December 22nd.

27,040. "An improved electric bell." D. Reid. Dated December 22nd.

27,053. "Improved overhead electrical wire holder." F. Foy. Dated December 22nd.

27,074. "Improvements in electrodes for arc lamps." W. E. Irish. Dated December 22nd. (*Complete.*)

27,097. "Improvements in arc lamps." H. R. Ottesen. Dated December 22nd. (*Complete.*)

27,113. "An improved process of the application of metals by electrolysis to or on the surface of earthenware either in the biscuit or glost state." G. W. Laybourn. Dated December 23rd.

27,142. "Improvements in or relating to electrically-driven ventilating fans." W. A. Burns. Dated December 23rd.

27,183. "A new material for electrical insulation." A. Smith. Dated December 23rd.

27,254. "Improvements in electric arc lamps." C. Wood. Dated December 24th.

27,268. "Improvements in connection with alternate current arc lamps and lanterns." W. M. Mordey and H. Bevis. Dated December 24th.

27,269. "Improvements in and connected with apparatus for measuring electricity." H. G. Kunkelmann, C. E. Francois, and C. E. Louberg. Dated December 24th.

ELECTRICAL PATENTS OF 1885 EXPIRING IN JANUARY, 1899.

We are informed by Messrs. W. P. Thompson & Co., that about 90 applications for electrical patents were filed in the month of January, 1885. Out of these some were never completed, and of those that were only one has been allowed to run its full length of term, viz., 14 years, and being of considerable interest, we give a short abstract below:—

819. "An improved mode of making and breaking electric circuits." V. Willis. Dated January 20th, 1885. Relates to apparatus for making and breaking contact, operated by a piston, key, or lever when required to actuate mechanism which in itself requires time to recover or rest itself after each impulse. The invention is described principally as applied to the keyboard of an organ. The apparatus is designed so that the circuit shall be made or broken at the commencement of each movement, and remain in the same condition until the movement ceases. In the figure, there is an organ key carrying at its end a bent spring terminating in a contact piece. The spring is in connection with a pin, which permanently dips into the mercury trough, extending the full length of the keyboard is a sliding metal plate in connection, through the mercury cup, with the electro-magnets or other mechanism. The sliding plate is bent at each end to enter the recesses in the end of the key lever and in the permanent wooden structure; a pointed rod is held between the spring and the plate, its use being to retain the plate in any required position. The plate is provided with a contact plate of platinum and an insulating plate of ivory, against one or other of which the contact piece bears.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool Manchester, and Birmingham, *price, post free,* 9d. (*in stamps*).

1895.

21,523. "Improvements in and connected with the supply of electric and pneumatic power to railway vehicles and the like." R. C. Sayer. Dated November 13th, 1895. Relates to improvements in the supply of electric and pneumatic power to railway vehicles, the electric or pneumatic power being generated at fixed stations on the line of the way, whether standing, or during transit. The invention refers to specifications 11,498 of 1895, and 15,192 of 1894. When the motors are electric, and the air used for subsidiary purposes only, and the current is carried by more than one conductor each side of the rail tube, the radials pick up a part only, or the whole current by their projected length reaching only one or more, or all such conductors, and when their projection is so great as to prevent their passing between the rail teeth, the wheel teeth are produced as flanges, and the wheels are left in step tangentially by the tread of the wheels carrying teeth equally spaced between the valve pins, and engage with others formed in the rail, or on the inside of a pair of rail heads. 3 claims.

1896.

8,316. "Improvements in electric switches." E. H. Wright, J. J. Heckman, A. H. Graves, C. C. Camahan, and W. H. Camahan. Dated April 21st, 1896. The invention relates to improvements in electric switches, and more specifically to an improved multiple contact switch especially adapted for simultaneously effecting a change of polarity or circuit in a plurality of conductors connected with or controlled by a switch. 7 claims.